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The purpose of this study is to ascertain whether the Sapper Lane Assault Marking System (SLAMS) will enhance light infantry and the light combat engineer's capability to standardize minefield marking. It was hypothesized that SLAMS is a critical asset for providing rapid and deliberate minefield marking of obstacles on restrictive and severely restrictive terrain for light infantry and light combat engineers on the battlefield. The study explains the rationale behind the construction and the employment of SLAMS on today's battlefield. The study also discusses the importance of SLAMS' integration into the light community and how SLAMS serves as a combat multiplier for light combat engineers and light infantry leaders. A survey was administered to a group of subject matter experts comprising infantry and engineer leaders, the U.S. Army Engineer School, and personnel assigned to the combat training centers (CTC). Results of the survey are analyzed and discussed. The study concludes that SLAMS can enhance light infantry and light combat engineer's capabilities to provide rapid and deliberate minefield marking of obstacles. SLAMS' lightweight and day and night capability appealed to leaders in the field. However, more testing and observations must be conducted before SLAMS is fielded for use on the battlefield.

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THE SAPPER LANE ASSAULT MARKING SYSTEM

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

BARRY K. WILLIAMS, MAJ, USA
B.S., Rust College, Holly Springs, MS, 1988
M.A., Webster University, Washington, DC, 1999

Fort Leavenworth, Kansas
2000

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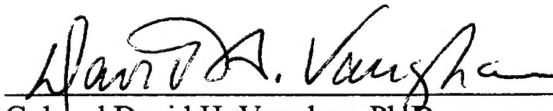 , Member, Consulting Faculty
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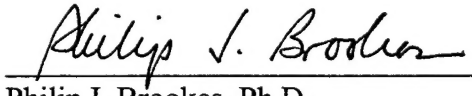 , Director, Graduate Degree Programs
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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

THE SAPPER LANE ASSAULT MARKING SYSTEM by Major Barry K. Williams, USA, 85 Pages.

The purpose of this study is to ascertain whether the Sapper Lane Assault Marking System (SLAMS) will enhance light infantry and the light combat engineer's capability to standardize minefield marking.

It was hypothesized that SLAMS is a critical asset for providing rapid and deliberate minefield marking of obstacles on restrictive and severely restrictive terrain for light infantry and light combat engineers on the battlefield.

The study explains the rationale behind the construction and the employment of SLAMS on today's battlefield. The study also discusses the importance of SLAMS' integration into the light community and how SLAMS serves as a combat multiplier for light combat engineers and light infantry leaders.

A survey was administered to a group of subject matter experts comprising infantry and engineer leaders, the U.S. Army Engineer School, and personnel assigned to the combat training centers (CTC). Results of the survey are analyzed and discussed.

The study concludes that SLAMS can enhance light infantry and light combat engineer's capabilities to provide rapid and deliberate minefield marking of obstacles. SLAMS' lightweight and day and night capability appealed to leaders in the field. However, more testing and observations must be conducted before SLAMS is fielded for use on the battlefield.

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ABBREVIATIONS

AOR	Area of Responsibility
APC	Armored Personnel Carrier
BCT	Brigade Combat Team
BFV	Bradley Fighting Vehicle
CCP	Casualty Collection Point
CGSC	Command and General Staff College
CARL	Combined Arms Research Library
CONUS	Continental United States
CTC	Combat Training Center
DC	Displaced Civilians
FEBA	Forward Edge of the Battle Area
HEMMS	Hand-Emplaced Minefield Marking Set
HMMWV	High Mobility Multipurpose Wheeled Vehicle
IPB	Intelligence Preparation of the Battlefield
ISB	Initial Staging Base
JRTC	Joint Readiness Training Center
MMAS	Master of Military Art and Science Degree
MOUT	Military Operations on Urbanized Terrain
NATO	North Atlantic Treaty Organization
OC	Observer-Controller
OCONUS	Overseas Continental United States
OOTW	Operations Other Than War

ORP	Objective Rally Point
SAW	M249 Squad Automatic Weapon
SLAMS	Sapper Line Assault Marking System
SOP	Standard Operating Procedures
TDA	Table of Distribution and Allowances
TF	Task Force
TO&E	Table of Organization and Equipment
TRADOC	Training and Doctrine Command
TTP	Tactics, Techniques and Procedures

CHAPTER 1

INTRODUCTION

Background

Despite the light infantryman's and light combat engineer's almost unanimous plea for a lightweight obstacle marking system that can be carried by the light infantry and light combat engineer soldier onto the battlefield, there has not been a system implemented to meet this need. Light infantry and light combat engineers are continually faced with operations on restrictive terrain where most equipment for combat has to be man-packed to its location. The physical limitations placed on light forces are more severe than for mechanized forces. Light soldiers can not attach pickets and wire to their Bradley Fighting Vehicle (BFV) or Armored Personnel Carrier (APC) for transport. Pickets and wire are needed throughout the battlefield to mark obstacles that continuously cause friendly forces and innocent civilians numerous causalities.

In today's environment of competing demands and limited resources, designing a system that can be introduced to the battlefield at a very low cost is imperative. SLAMS is a easily constructed and low cost system that can provide light combat engineers and light infantry soldiers with a viable obstacle marking solution.

SLAMS has been a part of the military inventory for years. In fact, SLAMS is a system that can be produced from locally procured materials often found at the small unit level. In early 1996, prototypes of SLAMS were developed and utilized at the Joint Readiness Training Center (JRTC) with great success.

The SLAMS prototype is a very basic minefield marking system, which can be employed by any soldier trained at skill level one. SLAMS is currently being used in

several areas. For example, SLAMS prototypes have been used during rehearsals to simulate marking of enemy-breached obstacles. An infantry company from the Austrian Army also used SLAMS prototypes during rehearsals at the Joint Readiness Training Center to simulate marking of enemy breached obstacles, and Charlie Company, 326th Engineer Battalion (Combat) (Air Assault) from Fort Campbell, Kentucky used SLAMS on their recent deployment to the Sapper Leader Course at Fort Leonard Wood in July of 1999.

Historical Perspective

Traffic cones, highway markers, hand-emplaced minefield marking sets (HEMMS), and tippy toms are some of the Army's first and oldest obstacle assault marking systems. These systems were widely used during Operation Desert Shield/Storm and are commonly seen at the combat training centers (CTC) today. These systems have proven over time that they are extremely viable for mechanized units who have the ability to carry these systems onto the battlefield. The advantages offered by traffic cones, highway markers, HEMMS and tippy toms to mechanized forces are: day and night obstacle marking capability, highly visible system and ease of employment, all of which appeal to the combat leaders in the field. For light units, however, acceptance of these systems has been met with resistance. The resistance is due primarily to the disadvantages offered to light forces such as: the irregular shape of traffic cones, highway markers and tippy toms limit the number a light combat engineer or light infantry soldier can carry; these obstacle marking systems also increase soldier exposure to direct and indirect fires when light combat engineer or light infantry soldiers are

directed to employ them; these obstacle marking systems cannot be air inserted with the light combat engineer or light infantry soldier onto the battlefield; and the traffic cones, highway markers and tippy toms are too cumbersome to man-pack across restrictive and severely restrictive terrain. Because of these problems, the light combat engineer community has continuously researched and developed marking systems tailored to the needs of the light combat soldier and engineer.

Yesterday's Technology

For many years, traffic cones, highway markers, HEMMS, and tippy toms have been used by infantry and engineer units as their primary lane assault marking systems. All these systems have been fielded and employed at the tactical level. The traffic cones, highway markers, HEMMS, and tippy toms are all accepted marking systems. These systems are used around the world by infantry and engineer units. However, these systems do have several tactical weaknesses. They are all too heavy to man-pack; speed of employment is slow; they can not be air inserted or attached to a soldier; and they require at minimum, a high mobility multi-purpose wheeled vehicle (HMMWV) with trailer to transport even short distances.

The SLAMS is a viable system to replace traffic cones, highway markers, HEMMS and tippy toms in air assault, airborne and light divisions. The SLAMS remedies many of the weaknesses associated with the traffic cones, highway markers, HEMMS and tippy toms. However, the SLAMS also has its weaknesses. For example, it is not as durable as the other systems over an extended period of time.

This paper examines the impact that SLAMS has had on the light engineer unit's ability to support the obstacle marking requirements of light maneuver units. A detailed history of the SLAMS is not the issue to be studied. The effectiveness of the SLAMS for light combat engineer and light infantry units, or more specifically, the effectiveness of the SLAMS to mark obstacles faster while reducing exposure to soldiers is the question that must be answered.

The Research Question

Will the Sapper Lane Assault Marking System (SLAMS) enhance light infantry and light combat engineer's capability to standardize minefield marking?

The research objective is to determine whether mobility support, in the terms of equipment assets, are sufficient to enable light combat engineers and light infantry to conduct obstacle marking on restrictive and severely restrictive terrain. And secondly, to examine some of the implications this lack of equipment support has on the soldier on today's battlefield.

This research will highlight and analyze SLAMS' capabilities in comparison to traffic cones, highway markers, the hand-emplaced minefield marking set (HEMMS) and the tippy toms marking systems. Each marking system has its own unique marking capabilities as well as limitations.

Subordinate Questions

In order to conduct this research, the following subordinate questions had to be addressed. The subordinate questions are listed below.

1. Is SLAMS durable and reliable enough to support marking of obstacles on restrictive and severely restrictive terrain?

2. How should SLAMS best be integrated into offensive and defensive operations?

3. Is SLAMS a cost-effective system for the Army and light combat engineer and light infantry units?

4. Will SLAMS be acceptable to leaders in the field?

Research Methodology

This project began as an idea of how SLAMS might be used to enhance light infantry and light combat engineer's ability to standardize minefield marking on restrictive and severely restrictive terrain. In order to obtain information on the problems associated with light units and their capability to mark obstacles on restrictive and severely restrictive terrain several light combat engineers and light infantry unit leaders were contacted, interviewed and surveyed. The sources used to conduct research included personal interviews with subject matter experts, extensive literature reviews of articles and books and other sources in the Combined Arms Research Library, as well as the internet. This process provided the opportunity to construct a SLAMS prototype. It was emailed to all surveyed participants along with an information paper on SLAMS to assist leaders in visualizing the concept. The survey proved to be invaluable because it became the focus of the research paper. Upon completion of the survey, leaders expressed their interest in the SLAMS concept as a viable lightweight obstacle marking

system to support marking obstacles on restrictive and severely restrictive terrain by light combat engineer and light infantry soldiers. After review of the survey results, respondents repeatedly asked four common questions. These questions are found and addressed in chapter 5, "Summary." Chapter 6, "Conclusions and Recommendations," accurately reflects leaders' concerns in the field and future research questions were identified based solely on leaders' concerns and questions.

Delimitations

The research for this study will be limited to light infantry and light combat engineer units, observer-controllers at the Joint Readiness Training Center (JRTC), and the Maneuver Support Battle Lab at the U.S Army Engineer Center.

Due to the relatively short time frame of CGSC, this study will focus on a limited study of the minefield marking system. The data presented will mostly reflect the concerns of leaders in light engineer and light infantry units and will not be focused on combat heavy engineers and mechanized infantry units and their minefield marking systems. Finally, all data should be validated prior to any unit fielding.

This study will not attempt to be an in-depth analysis of our current minefield marking systems. In addition, it is beyond the scope of this study to determine the cost savings of SLAMS over current systems, nor will this study attempt to predict actual savings incurred by fielding SLAMS.

The conclusions and recommendations should be treated carefully due to the limitations of this study. The U.S. Army Engineer Center should validate all conclusions and recommendations prior to fielding.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

This chapter will provide a review of the literature that was examined during the research process. Information on the history and performance of SLAMS is limited. The sources that provided significant information were the Combined Arms Research Library at Fort Leavenworth, the U.S. Army Engineer Center at Fort Leonard Wood, instructors from the Sapper Leader Course at Fort Leonard Wood, observer-controllers' (OC) reports and observations from the Joint Readiness Training Center at Fort Polk, comments from officers and noncommissioned officers, and soldiers' observations in the field based on their use of SLAMS to support maneuver units.

Combined Arms Research Library

Research of the technical and nontechnical documents within the Combined Arms Research Library (CARL) produced several documents that discussed traffic cones, highway markers, the hand-emplaced minefield marking set (HEMMS) and tippy toms. There were several articles that discussed marking obstacles, but there was limited documentation found that focused on marking obstacles in restrictive and severely restrictive terrain.

This, in itself, makes the SLAMS research worth doing because of the present lack of information on obstacle marking systems in restrictive and severely restrictive terrain. Information that discusses tactics, techniques and procedures for operating and marking obstacles in these types of environments is needed. Light infantry and engineer

units in the future will find themselves operating more and more in environments where the infrastructure will not support heavy vehicle traffic. Light units must start developing standard operating procedures to prepare themselves to conduct missions ranging from peacekeeping to combat operations in restrictive and severely restrictive terrain.

Additional research was conducted in the library to locate information on existing lightweight obstacle marking systems. Today limited articles exist on light obstacle marking systems. Hopefully, in the near future more information will be made available in the library to compare and contrast obstacle marking systems capabilities and limitations.

Maneuver Support Battle Lab at Fort Leonard Wood Comments

Colonel Gregory G. Bean, the Deputy Director of the Maneuver Support Battle Lab at the U.S. Army Engineer Center is very interested in SLAMS. Colonel Bean, having been a former battalion commander of the 65th Engineer Battalion (Light) in Hawaii, clearly understands the need for a lightweight obstacle marking system.

Colonel Bean stated that, as a battalion commander he saw many different obstacle marking systems used within his battalion in Hawaii. Colonel Bean further stated that, light infantry units had many different ways of marking obstacles but seldom did two units have similar marking techniques. Colonel Bean also stated that, since SLAMS reduces the number of soldiers required to mark an obstacle, this would allow more light engineers and infantry soldiers to provide suppression fires on the enemy doing the actual breaching operation. Colonel Bean believes that, since it requires less soldiers to employ SLAMS as an obstacle system, maybe light units should require more

lanes to be breached to pass light assault forces through obstacles quicker and prevent the enemy from massing fires on a particular breach location. Finally, Colonel Bean believes SLAMS increases a soldier's survivability rate during breaching operations by limiting the exposure time of soldiers to direct and indirect fires executing breaching and marking operations.

Colonel Bean requested that all the research findings be forward to the Maneuver Support Battle Lab at the U.S. Army Engineer Center so further studies and testing could be conducted (Bean 2000).

The Sapper Leader Course Instructor Observations and Comments

The Sapper Leader course is a leadership school that trains company grade engineer leaders, both officers and noncommissioned officers in the grades of corporal to captain, in light engineer and infantry tactics. The Sapper Leader course is mainly used to train light engineer units, but some combat heavy engineers do attend.

The Sapper Leader course is similar to Ranger school, but is focused more on engineer type missions, such as bridge destruction, route reconnaissance, or demolition. The training is conducted over a four-week period and leadership positions are rotated between members of the unit being trained. The observer-controllers evaluate the unit leadership in their execution and conduct of light combat engineer and infantry missions under simulated combat conditions.

The course is designed to allow leaders to professionally develop each other while building a cohesive team by working together and complementing each other's weaknesses and identifying leader strengths. Throughout the training the leaders will

have to execute different missions under a variety of stressful conditions. To create stress on the leaders being evaluated, the Sapper Leader course observer-controllers will reduce the amount of sleep and food leaders will receive or consume per day. The Sapper Leader course observer-controllers will also assign mission time constraints that require leaders to move faster and cover more distance to accomplish their missions.

Some of the training conducted at the Sapper Leader course is as follows: the Army Physical Fitness Test (APFT); Medical Considerations classes; Mine Awareness class; Land Navigation review; Terrain Association; Hand-to-Hand Combat; Night/Day Land Navigation; Water Confidence Test; Battle Drill/Patrolling Techniques; 12-mile Foot March; Troop Leading Procedures; Conventional Demolition training; Expeditious Demolition training; and Mountaineering training.

Upon completion of the Sapper Leader course training, units return to home station where they design training programs to correct deficiencies identified by the Sapper Leader course observer-controllers.

Sergeant First Class Jaime Perez, the Senior Noncommissioned Officer and Instructor at the Sapper Leader Course at Fort Leonard Wood, Missouri, stated that: Prior to Charlie Company, 326th Engineer Battalion (Air Assault), he had never witnessed a unit training at the Sapper Leader course with a lightweight obstacle marking system similar to SLAMS.

Sergeant First Class Perez also stated that SLAMS would be an ideal system to integrate into light combat operations in restrictive and severely restrictive terrain. His justification was that the light weight of SLAMS allows light combat engineers, as well as light infantry, a greater capability to mark obstacles for follow-on units. Sergeant First

Class Perez stated that light combat engineers and light infantry have always had a limited obstacle marking capability when conducting operations on restrictive and severely restrictive terrain. Light units have always deployed to combat environments where there were many competing demands on what items were needed or required to accomplish the mission. Obstacle marking in most cases will always be considered a last priority behind food, water, ammunition, radios, and batteries. With that said, a soldier can only carry so much in a rucksack. Usually there is limited space left in a soldier's rucksack, if any, once all the mission essential equipment is uploaded for the mission. The smaller designed SLAMS can be carried or tied to the rucksack during movement. When you consider the weight and irregular shapes of traffic cones, highway markers, HEMMS, and tippy toms, all these systems are just to cumbersome for light units to carry onto the battlefield. SLAMS can change the way light combat engineers and light infantry operate on restrictive and severely restrictive terrain. Hopefully, leaders will train with SLAMS and develop tactics, techniques and procedures (TTPs) that light units can use in the future (Perez 2000).

Joint Readiness Training Center Observer-Controller Comments

Major John Dejarnett, a Command and General Staff College student and former observer-controller from the Joint Readiness Training Center (JRTC) has seen many different attempts by light units to implement lightweight obstacle marking systems. He stated that: "I do not recall seeing SLAMS used at JRTC, but believe that the SLAMS concept is one of the better obstacle marking systems, in concept, that I have seen to date." He further stated that, every company and platoon he observed at JRTC had its

own marking systems, which in most cases were dictated by battalion task force (TF) or company team standard operating procedures (SOP). Major Dejarnett is concerned with the durability of the SLAMS marking system. He indicated that his experience at JRTC taught him that marking systems must be durable to decrease the likelihood of soldiers and displaced civilians (DC) wandering into a obstacle where someone has removed the marking system. Furthermore, marking systems must be somewhat difficult to remove, thus preventing enemy units and civilian loyalists from taking down the system which would allow innocent people to be harmed.

Major Dejarnett likes the ease of employment of SLAMS. He stated that, SLAMS makes it a lot easier for soldiers to conduct covert lane marking since SLAMS is a lightweight system. He also believes that since SLAMS has a night capability, units will be able to move about the battlefield safer than ever before. Major Dejarnett likes the idea that SLAMS requires less soldiers to mark an obstacle, but he believes that units should provide security over the obstacle until a more permanent system such as wire and pickets can be emplaced. Major Dejarnett does believe that light units should construct and train with SLAMS to validate SLAMS for light units. He concluded by saying that, should the marking system be acceptable to light combat engineers and light infantry leaders in the field, SLAMS should be fielded (Dejarnett 2000).

SLAMS Users Observations and Comments

Comments and observations from leaders and soldiers in the field provides the most critical information about SLAMS. In order to conduct a good comparison of SLAMS, telephonic interviews were conducted with soldiers who had trained with

SLAMS and several other marking systems. Discussions were focused directly on the soldiers' perception of what they believed the capabilities and limitations of each marking system was when operating on restrictive and severely restrictive terrain. Soldier experience with different marking systems was critical since there was limited information in the Combined Arms Research Library.

Soldiers tended to favor SLAMS over the other marking systems because it was less cumbersome to employ; it was lighter in weight and it could be employed faster than the other systems. Additionally, an information paper, survey and a picture was sent to several light engineer units located in the continental United States (CONUS) and overseas. A copy of the sapper lane assault marking system survey and picture are included in appendix A and B, respectively.

Private Richard Tulley is a Combat Engineer, 12B, in second squad, first platoon, Charlie Company, 326th Engineer Battalion (Air Assault). He stated that SLAMS was the only assault obstacle marking system he had trained with since arriving at Fort Campbell, but he was familiar with traffic cones and highway markers from basic training. He went by saying that, traffic cones and highway markers were too heavy for his squad to carry on foot marches to support the light infantry with effective breaching and marking of obstacles on restrictive and severely restrictive terrain. Private Tulley concluded by saying that, SLAMS was quicker to employ than traffic cones and highway markers and that SLAMS lightweight makes it easier to carry on patrols (Tulley 2000).

Private First Class William Sutton is a Combat Engineer, 12B, in third squad, second platoon, Charlie Company, 326th Engineer Battalion (Air Assault). He stated that SLAMS was the best marking system he had used while at Fort Campbell. His squad had

tried using a pop and drop liquid chemical light method to mark obstacles on restrictive terrain at night. The pop and drop liquid chemical light method is an expeditious method of marking obstacles. A soldier drops liquid chemical lights along a cleared path that the infantry can assault through to get onto an objective. The major problem with this method is most of the time as the light infantry runs through the footpath that is marked, soldiers accidentally kick or the wind blows the liquid chemical light out of the marked lane that has been proofed. Light units have to carry everything needed for the mission in their rucksack. SLAMS is a lot lighter and easier to employ than the traffic cones used by my squad in Germany (Sutton 2000).

Specialist Charles Wood is a Combat Engineer, 12B, in third squad, third platoon, Charlie Company, 326th Engineer Battalion (Air Assault). He stated that, SLAMS was the easiest obstacle marking system he had ever used. When asked why would he make such a comment, he said that; It only requires one person to employ SLAMS and that allows the rest of the squad to provide security (Wood 2000).

SLAMS Supervisors' Observations and Comments

Sergeant Major Donald Motter, a former First Sergeant of Charlie Company 326th Engineer Battalion (Air Assault) stated that, Staff Sergeant Linsey, a former squad leader of second platoon Charlie Company, and his squad members designed SLAMS in order to reduce the load they had to carry across rough terrain in support of the light infantry. After the construction of SLAMS and the training was conducted, SSG Linsey and his squad trained the infantry on how to employ SLAMS. The infantry units liked SLAMS because it was easily constructed, lightweight and it is very easy to employ.

SLAMS appeals to leaders because it requires no additional training to employ SLAMS. SLAMS enhances SSG Linsey's soldier morale to conduct long range patrols with the infantry because SLAMS is not as cumbersome as the previous assault obstacle marking systems used by their Task Force. SLAMS is an excellent marking system that has worked well during our tactical employment of it during Gold Cycle (training cycle) (Motter 2000).

Master Sergeant Robert Beach, a former First Sergeant of Charlie Company, 326th Engineer Battalion (Air Assault) stated that, while serving as a First Sergeant in Charlie Company all three platoons were using SLAMS with their light infantry task forces. We even used it at JRTC during our March 1997 rotation with excellent results. SLAMS is a quick and easy system to construct at home-station or in a tactical environment. SLAMS can also be tailored to suit any mission if information is known about the enemy and about the obstacle early enough. When information is limited about the enemy and the obstacles, SLAMS can be constructed in the objective rally point (ORP) after the leader's reconnaissance is conducted and more information is known about the obstacle. Since SLAMS can be constructed in two or three minutes by any soldier, construction of SLAMS can be done anywhere on the battlefield if they have the materials with them. (Beach 2000).

Sergeant First Class Donald Kelly a former platoon sergeant of Charlie Company, 326th Engineer Battalion (Air Assault) stated that, SLAMS is the best solution we have right now to support our task force with assault breaching on restrictive and severely restrictive terrain. The cost is minimal and it's easy to employ compared to traffic cones,

highway markers and tippy toms. SLAMS is very simple system to use and its lighter than the other assault marking systems that exist today (Kelly 2000).

Sergeant First Class Richard Williams a former squad leader in Charlie Company, 326th Engineer Battalion (Air Assault) stated that, SLAMS simplified the assault breach marking procedures for his squad. SLAMS allows more of the squad to provide security. SLAMS also limits the weight soldiers have to carry onto the battlefield (Williams 2000).

Sergeant First Class Curtis Wilson a former squad leader in Charlie Company, 326th Engineer Battalion (Air Assault) stated that, SLAMS is the best assault marking system I've used in twelve years of service. The Army's leadership in the field needs to train with SLAMS and adopt this assault marking system. SLAMS should be fielded to light and heavy units. Traffic cones, highway markers and tippy toms take up too much room in tracked and wheeled vehicles (Wilson 2000).

Personal Observations and Comments

As requirements continue to grow for light units to mark obstacles on restrictive and severely restrictive terrain, the need for a lightweight marking system will become more and more critical. The speed in which light combat engineers and light infantry can mark obstacles on the battlefield is directly related to the vulnerability of soldiers to direct or indirect fires. Light combat engineer and light infantry's ability to identify, access, report and mark obstacles continues to reduce fratricide and injury to displaced personnel/civilians in a variety of environments.

Although many organizations have their own unit level standard operating procedures (SOP) for marking obstacles, they are not standardized within platoon, companies, battalions and brigades. Many organizations have given their subordinate units the flexibility to develop their own obstacle marking system. Not all units fully understand the benefits of maintaining a standard marking system across all units. Today's challenge is for organizational leaders to develop and implement sensible obstacle marking techniques and procedures that will enforce marking standards. SLAMS provides this consistency for light combat units.

Introduction to Traffic Cones

Traffic cones are used around the world to direct civilian and military wheeled and tracked automotive traffic flow. Traffic cones are in abundant supply. However, traffic cones are not the most effective means for light combat engineers and light infantry to mark obstacles on restrictive and severely restrictive terrain.

Description of Traffic Cones:

Traffic cones are manufactured from 100 percent polyvinyl chloride (see figure 1). The polyvinyl chloride provides a brilliant fluorescent orange color for maximum daytime visibility. Traffic cones can also be purchased with a flashing cone light that enhances its use during reduced visibility (nighttime). Traffic cones can be designed and purchased in six different sizes and four different heights. The six different sizes and four heights that can be purchased are: twelve inches without reflective tape; eighteen inches without reflective tape; eighteen inches with a six inch stripe of reflective tape around it, eighteen inches with a four and a six inch stripe of reflective tape around it;

twenty-eight inches without reflective tape; and thirty-six inches without reflective tape. The traffic cones that are designed with the reflective tape around them provide very limited reduced visibility capability, but they are better during limited visibility than those without reflective tape. Traffic cones weigh approximately five to ten-pounds according to their size and height.

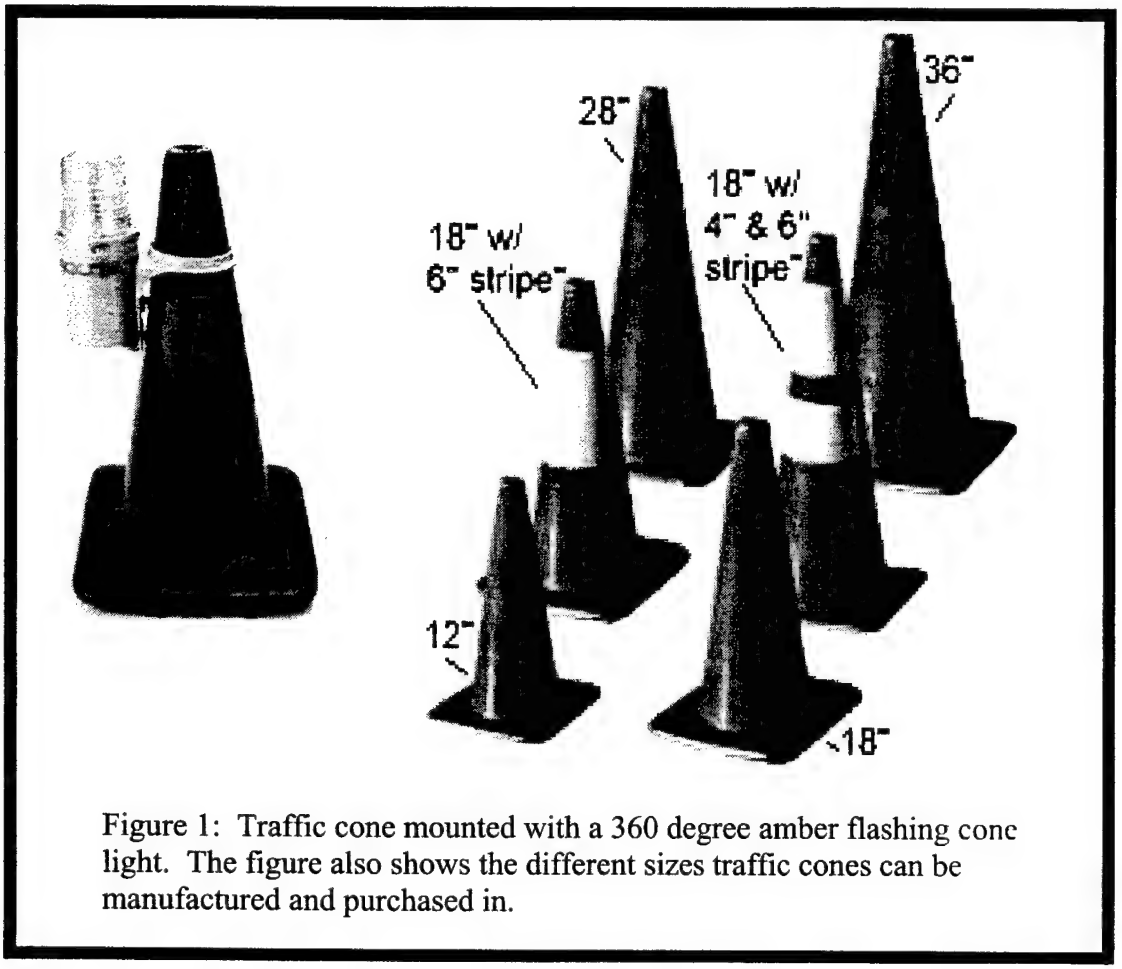


Figure 1: Traffic cone mounted with a 360 degree amber flashing cone light. The figure also shows the different sizes traffic cones can be manufactured and purchased in.

Traffic cones can range in price from approximately eighteen to forty-eight dollars if purchased with amber flashing cone light. Each traffic cone and flashing cone

light is sold separately. Traffic cones are primarily used when rapid emplacement and short duration obstacle marking is desired. Traffic cones are a recoverable system.

Use of Traffic Cones

Traffic cones are used by civilians and military units to direct traffic flow of privately owned vehicles (POV) and military tracked and wheeled vehicles on the battlefield. Traffic cones are usually associated more with heavy mechanized forces because mechanized forces have greater haul capabilities than light units. Mechanized units will usually dedicate trucks and trailers to haul the heavy traffic cones to where they will be used to direct traffic or mark obstacles. Light units do not have the same vehicle haul capability as mechanized units, therefore traffic cones are not suitable for light units operating on restrictive and severely restrictive terrain. Additionally, light units will most likely be operating on terrain that does not support the use of vehicles. With that said, light units must be prepared to carry obstacle-marking equipment onto the battlefield in their individual equipment. Mission essential equipment such as radios, ammunition and water are first priority for light units, to and therefore after the mission essential equipment is placed in the rucksacks, there is limited space available to place the irregular shaped traffic cones.

Advantages of Traffic Cones

1. Traffic cones have a better reduced visibility capability especially when the flashing cone light is used.

2. Traffic cone weight prevents the wind from pushing them over and leaving gaps in marked obstacles.

3. Traffic cones' are lighter in weight than highway markers.

Disadvantages of Traffic Cones

1. Traffic cones irregular shape and weight of five to ten pounds prevents light combat engineers and light infantry from carrying them in their individual equipment.

2. Traffic cones decrease the mobility of light combat engineers and light infantry when conducting combat operations on restrictive and severely restrictive terrain.

3. When using traffic cones on the battlefield, soldiers and displaced civilians can wander into a minefield because of the spacing left between each emplaced traffic cone (usually five to ten meter spacing).

4. It requires twenty traffic cones (weighs approximately 150 to 200 pounds) to mark the same obstacle/distance that one SLAMS (weighs approximately three and half pounds) can be used to mark the same size obstacle.

5. It requires a squad of seven soldiers to carry twenty traffic cones onto the battlefield to mark an obstacle one hundred feet in depth and it only requires one soldier to carry SLAMS onto the battlefield to mark the same obstacle.

6. During assault breaches, more soldiers are exposed to direct and indirect fires when employing traffic cones. Only one soldier has to be exposed when emplacing SLAMS.

7. Light combat engineers and light infantry cannot use traffic cones to mark lanes across shallow streams or water crossing sites because they will flow away.

8. A wheeled or tracked vehicle is required to haul a sufficient number of traffic cones onto the battlefield.

Conclusion to Traffic Cones

Light units have minimal use for traffic cones on restrictive and severely restrictive terrain. Light units can use traffic cones in rear area operations where they may have haul capability. Light units need maximum flexibility when operating in environments where resupply options are limited. Traffic cones on restrictive and severely restrictive terrain decreases a light unit's flexibility and mobility due to the weight of the traffic cones. Finally, traffic cones does not fix the soldier load problems that exist today in light units, traffic cones just enhance these problems.

Introduction to Highway Markers

Highway markers are very similar to traffic cones in that they share many of the same capabilities and limitations for light units. There are a few differences between the highway marker and the traffic cone. Those differences will be discussed, but for the most part these two marking systems are similar in nature.

Description of Highway Markers

Highway markers are manufactured from 100 percent polyvinyl chloride. The polyvinyl chloride provides a brilliant fluorescent orange color for maximum daytime visibility (see figure 2). Highway markers are designed with two 3-inch wide reflective bands and measure 42-inches in height by 4-inches in diameter. A highway marker post

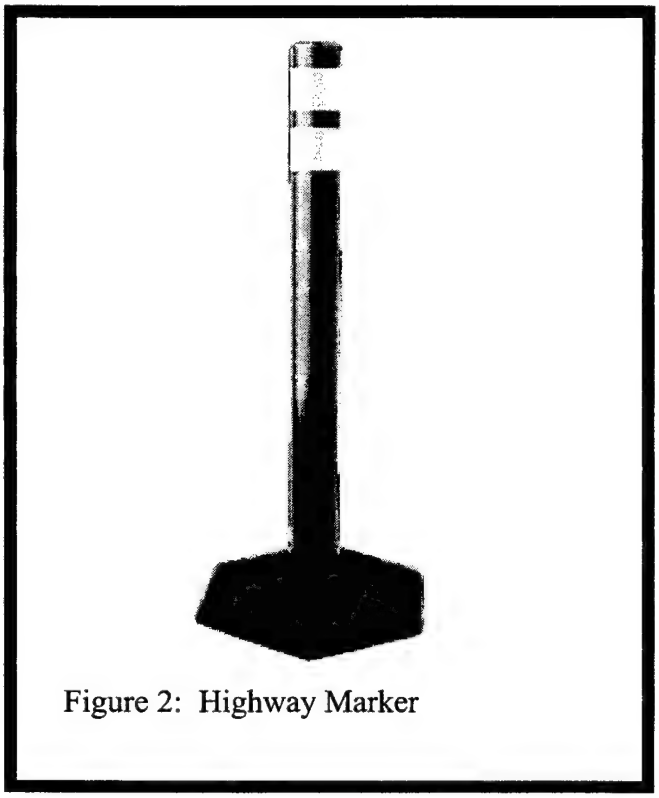


Figure 2: Highway Marker

weighs two-pounds and must be used with a twelve-pound or fourteen-pound base plate. The cost per 42-inch by 4-inch diameter post with the two 3-inch wide reflective bands is $30.35 per marker. The twelve-pound base plate costs $29.85 and the fourteen-pound base plate costs $34.02 each. The highway markers and the base plates are sold separately. Highway markers will primarily be used when rapid emplacement and short duration obstacle marking is desired. Highway markers are a recoverable system.

Use of Highway Markers

Highway markers and traffic cones can be used to direct traffic and mark obstacles in a similar fashion. Both systems, as stated above, are mainly associated with

mechanized heavy forces and wheeled units due to the haul requirement needed to get both systems to the marking sites on the ground.

Advantages of Highway Markers

1. Highway markers are highly visible.

2. Highway markers have a better reduced visibility capability than SLAMS or traffic cones.

3. Highway marker weight prevents the wind from blowing them over during high winds and leaving gaps in marked obstacles.

4. Light combat engineers and light infantry can use highway markers to mark lanes across shallow streams or water crossing sites.

Disadvantages of Highway Markers

1. Highway markers are too heavy; approximately fourteen to sixteen pounds each. The weight of highway markers prevent light combat engineers and light infantry soldiers from conducting foot marches across restrictive and severely restrictive terrain.

2. When using highway markers on the battlefield, soldiers and displaced civilians can wander into the minefield because of the spacing left between each emplaced highway marker (usually five to ten-meter spacing).

3. It requires twenty highway markers (weighs approximately 290 to 320 pounds) to mark the same obstacle/distance that one SLAMS (weighs approximately three and half pounds) can be used to mark the same obstacle.

4. It requires a squad of seven soldiers to carry twenty highway markers onto the battlefield to mark an obstacle one hundred feet in depth. It requires one soldier to carry SLAMS onto the battlefield to mark the same obstacle.

5. Highway markers have no reduced visibility (nighttime) capability. Highway markers are limited to daytime use only.

6. During assault breaches, more soldiers are exposed to direct and indirect fires when employing highway marker, only one soldier has to be exposed when emplacing SLAMS

7. Light combat engineers and light infantry cannot use traffic cones to mark lanes across shallow streams or water crossings sites because they will flow away.

8. A wheeled or tracked vehicle is required to haul a sufficient number of highway markers onto the battlefield.

Conclusion to Highway Markers

Highway markers are not viable for light combat engineers and light infantry on restrictive and severely restrictive terrain. Light units require a marking system that can be transported within the rucksack and that can be quickly employed to reduce casualties caused by enemy direct and indirect fires. Under the right conditions, highway markers can be used to mark obstacles. But their irregular shapes, weight, cost and inefficient employment makes it an unlikely candidate for use by light forces.

Introduction to Hand-Emplaced Minefield Marking Set

Hand-emplaced minefield marking set (HEMMS) is an excellent obstacle marking system for light combat engineers and light infantry soldiers (see figure 3). HEMMS is currently the only manufactured obstacle marking system in the Army's inventory that supports operations on restrictive and severely restrictive terrain. The HEMMS poles are a very durable system that provides light units with both day and night capability. HEMMS poles' lightweight enables light units to maximize their mobility on the battlefield without severely hampering soldiers' load. Additionally, HEMMS poles can be easily cut with a saw (tailor length) so that they can fit into a soldier's individual equipment.

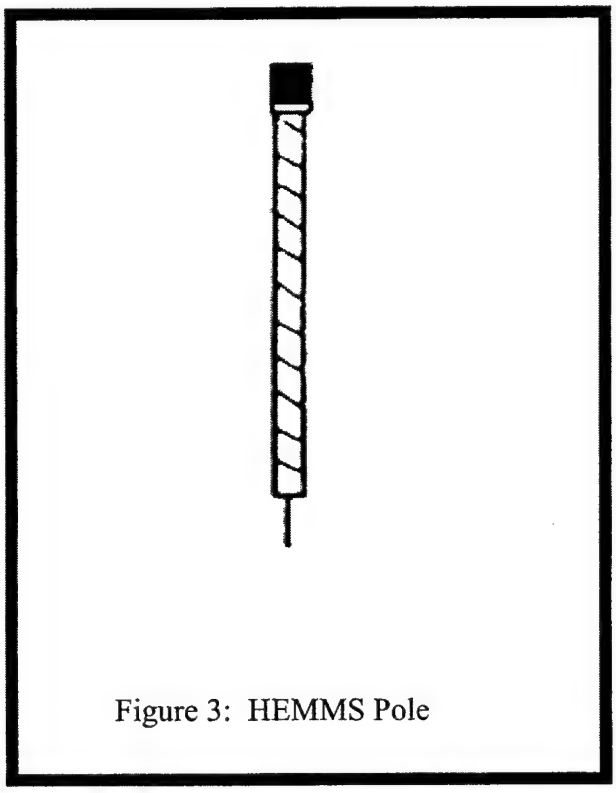


Figure 3: HEMMS Pole

Description of Hand-Emplaced Minefield Marking Set

The M133 HEMMS is a means of safely guiding friendly forces through or around scatterable or conventional minefields. The set consists of lights, signs, tape, wire, poles, pole driver, batteries and a storage chest. The set weights 174 pounds and can mark a lane 700 to 1,000 meters in length. A HEMMS marker is visible from 600 meters away during daylight and 235 meters at night. The flashing directional light (82 flashes per minute) can be seen only from the friendly side of the minefield. HEMMS will primarily be used when rapid emplacement and short duration obstacle marking is desired. HEMMS is a recoverable system.

Use of Hand-Emplaced Minefield Marking Set

HEMMS can be emplaced by a marking team in approximately twelve minutes when marking an obstacle that is one hundred feet in length. HEMMS is used by the Engineer support force during an assault breach to mark the entrance and exit of a breached lane for follow-on units/forces. HEMMS can also be used to mark lanes (after they have been widened by deliberate means) and friendly minefields.

Advantages of Hand-Emplaced Minefield Marking Set

1. No special training on installation, operation or maintenance needs to be conducted by service schools.

2. HEMMS is an accepted marking system by light units and is widely used during combined armed exercises when mine and countermine warfare are emphasized.

3. HEMMS is available through normal supply channels as a supply item.

Disadvantages of Hand-Emplaced Minefield Marking Set

1. HEMMS is expensive and cost more than SLAMS, traffic cones or highway markers.

2. Once HEMMS poles have been cut they can not be tailored again for another mission.

3. HEMMS weighs 174 pounds.

4. HEMMS poles can be cut and tailored only once to make it suitable for obstacle marking missions.

Conclusion to Hand-Emplaced Minefield Marking Set

HEMMS can provide light combat engineers with an acceptable, feasible and suitable obstacle marking capability. The cost of the HEMMS obstacle marking system will be greater than the cost to use SLAMS, but less than highway markers and traffic cones. HEMMS is available through normal supply channels. Production of HEMMS is complete and is accepted by light unit leaders in the field.

Introduction to Tippy Toms

Tippy toms like traffic cones and highway markers are not the most effective means for light combat engineers and light infantry to conduct assault obstacle marking (see figure 4) on restrictive and severely restrictive terrain. Though tippy toms can easily be produced at the company and platoon level, tippy toms still prevent light units with the same problems that traffic cones and highway markers do.

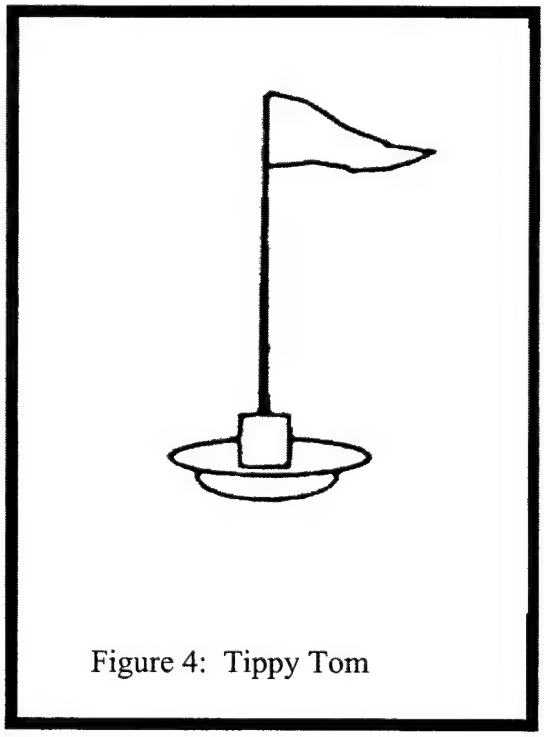


Figure 4: Tippy Tom

Description of Tippy Toms

Tippy toms are mainly used for assault obstacle marking. Tippy toms are made by placing a metal rod into a bowl shaped pan of cement that is dynamically stable. Dynamically stable is defined as, no matter how the tippy toms is emplaced during assault obstacle marking, it always returns to the upright position. When construction of tippy toms is complete it weighs approximately eight pounds. Liquid chemical lights can be attached to the tippy toms for use during periods of limited visibility and a flag for daytime use. Tippy toms will primarily be used when rapid emplacement and short duration obstacle marking is desired. Tippy toms are a recoverable system. They are employed like traffic cones and highway markers.

Use of Tippy Toms

Tippy toms are usually thrown out the back of a tracked or wheeled vehicle while conducting assault-breaching operations. The purpose of the vehicle is twofold. First, is to get the tippy toms to the marking site, and secondly, to provide cover to protect the soldiers while emplacing the marking system. Maneuver units usually provide a breach force with suppression fires to prevent enemy forces from engaging the breaching force with direct and indirect fires. Since most light units will not operate on terrain where tracked and wheeled vehicles can maneuver, tippy toms are not the most viable system available.

Advantages of Tippy Toms

1. Tippy toms weight prevents the wind from pushing them over and leaving gaps in marked obstacles.

2. Tippy toms are lighter in weight than highway markers and some traffic cones.

Disadvantages of Tippy Toms

1. Tippy toms irregular shape and weight of eight pounds limits light combat engineers and light infantry soldiers mobility when foot marching and carrying tippy toms in their individual equipment for extended periods of time on restrictive and severely restrictive terrain.

2. Tippy toms require a vehicle to transport obstacles marking system to the battlefield.

3. Tippy toms require a suppression force to provide cover as the soldiers drop them during an assault marking operations.

4. When using tippy toms on the battlefield, soldiers and displaced civilians can wander into a minefield because of the spacing left between each emplaced tippy toms (usually five to ten meter spacing).

5. It requires twenty tippy toms (weighs approximately 160 pounds) to mark the same obstacle/distance that one SLAMS (weighs approximately three and half pounds) can be used to mark the same size obstacle.

6. It requires a squad of seven soldiers to carry twenty tippy toms onto the battlefield to mark an obstacle one hundred feet in depth and it only requires one soldier to carry SLAMS onto the battlefield to mark the same obstacle.

7. During assault breaches, more soldiers are exposed to direct and indirect fires when employing tippy toms. Only one soldier has to be exposed when emplacing SLAMS.

8. Tippy toms cannot use to mark lanes across shallow streams or water crossing sites but SLAMS can be used to span gaps up to one hundred feet in length.

Conclusion to Tippy Toms

The disadvantages of tippy toms as a viable obstacle marking system for light combat engineers and light infantry units clearly outnumber the advantages. Tippy toms present the same challenges to light units as traffic cones and highway markers. The only small advantage that a tippy tom has over traffic cones and highway markers is the cost. Of all

the systems that can be used to conduct assault obstacle marking, tippy toms are the least viable.

CHAPTER 3

RESEARCH METHODOLOGY

Why SLAMS?

The intent of the research project is to determine whether SLAMS can enhance light infantry and light combat engineer's capability to mark obstacles on restrictive and severely restrictive terrain (see figure 5)?

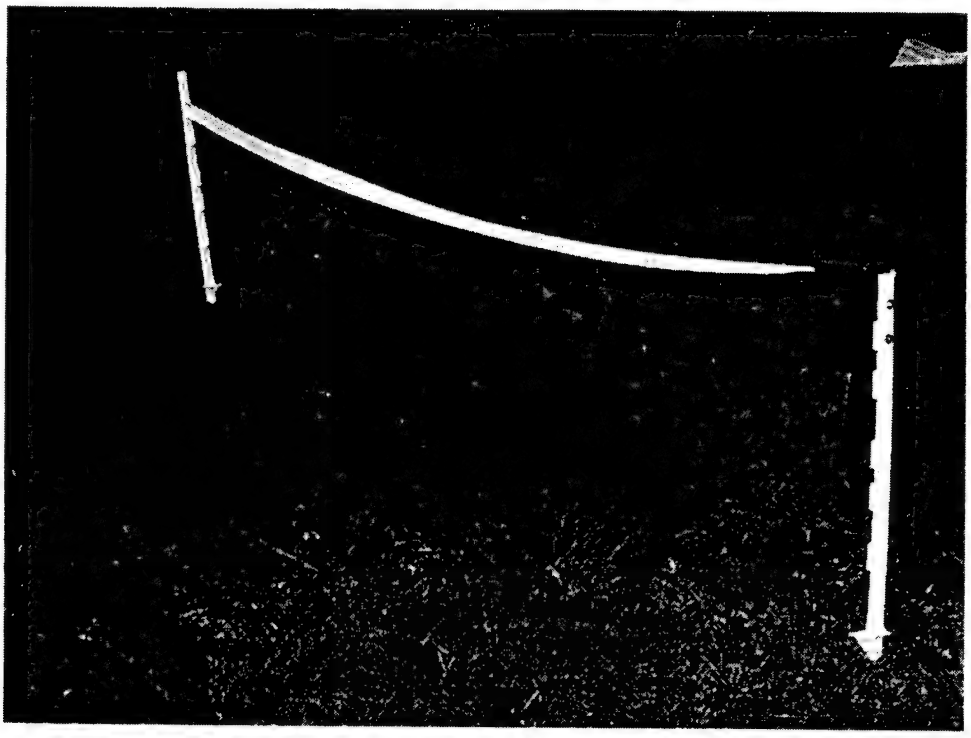


Figure 5: An emplaced SLAMS system.

For years the Army has tried to provide a standardized obstacle marking system that could be interchanged between light and heavy combat engineers and infantry units. Today that system still does not exist. There must be a clear paradigm shift in the way we

mark obstacles on restrictive and severely restrictive terrain. Light combat engineers and light infantry leaders must be able to sustain the fighting force in order to close with and defeat the enemy.

Are leaders paying enough attention to the increasing demands for light combat engineers and light infantry soldiers to operate on an obstacle saturated battlefield? Do our leaders clearly understand what light combat engineers and light infantry leaders require their soldiers to do? Are we going to allow soldiers to be exposed to direct and indirect fires for a longer time period than required? These are questions that need to be answered. SLAMS may be able to help.

SLAMS is a feasible, acceptable and suitable system. It is simple to construct, and it can be designed at minimal cost to the unit. SLAMS can be that obstacle marking system the Army adopts to increase proficiency in assault obstacle marking.

Momentum will continue to play a vital role in successful operations on the battlefield. SLAMS can support a maneuver units' mobility because of its lightweight. SLAMS weight is less than four pounds when assembled. Today there is no other assault marking system that allows soldiers to mark one hundred feet of an obstacle in both day and night scenarios within ten second or less. SLAMS provides this capability and more.

Scope of SLAMS

Historical evidence and current events increasingly support the argument that as today's battlefield becomes more lethal, minefield marking will play a larger role in the training and operations of light infantry and light combat engineers in tactical and non-tactical environments. This chapter will discuss specifics and provide concepts for the

employment of SLAMS across a broad spectrum of operations. The scope of SLAMS will generally be discussed in three broad areas: Offensive Operations, Defensive Operations, and Operations Other Than War (OOTW).

Composition of SLAMS

SLAMS is an ideal concept for light units because of its light weight and it is easily constructed out of common military supply items. In addition, SLAMS can be easily constructed and employed in both non-tactical or tactical environments.

SLAMS can be constructed from the following items: an empty M249 SAW canister; one hundred feet of white cotton tape; a 3¼-inch metal or wooden dowel; a crank (reel); two stakes (plastic, wooden or metal); and a metal or wooden retaining cap. To assemble SLAMS, follow these basic steps: (1) Take an empty M249 SAW canister (see figure 6), remove the lid, punch/drill two small holes in the back of the canister and secure a stake (wooden, plastic or metal) to the canister with screws (see figure 7). (2) Locate the center of the canister and punch/drill a hole in it and then pass a 3¼-inch metal or wooden dowel through it (see figure 8). (3) Attach a metal, plastic or wooden retaining cap (see figure 9) to one end of the 3¼-inch metal or wooden dowel (see figure 10). (4) Attach a crank (reel) (see figure 11) to the opposite end of the 3¼-inch metal or wooden dowel. (5) Attach the running end of a roll of one hundred feet of white cotton tape (see figure 12) to the 3¼-inch metal or wooden dowel; then use the attached crank (reel) to wind the one hundred feet of white cotton tape onto the canister. Prior to attaching the lid (see figure 6) to the canister, ensure the running end of the one hundred feet of white cotton tape is fed through the opening in the front of the canister. Finally,

(6) attach a stake (wooden, plastic or metal) to the running end of the one hundred feet of white cotton tape (see figure 7). Once assembled (see figure 5 or 14), SLAMS is ready for employment. Although the sizes of the stakes, screws, and dowels may vary, SLAMS construction remains the same.

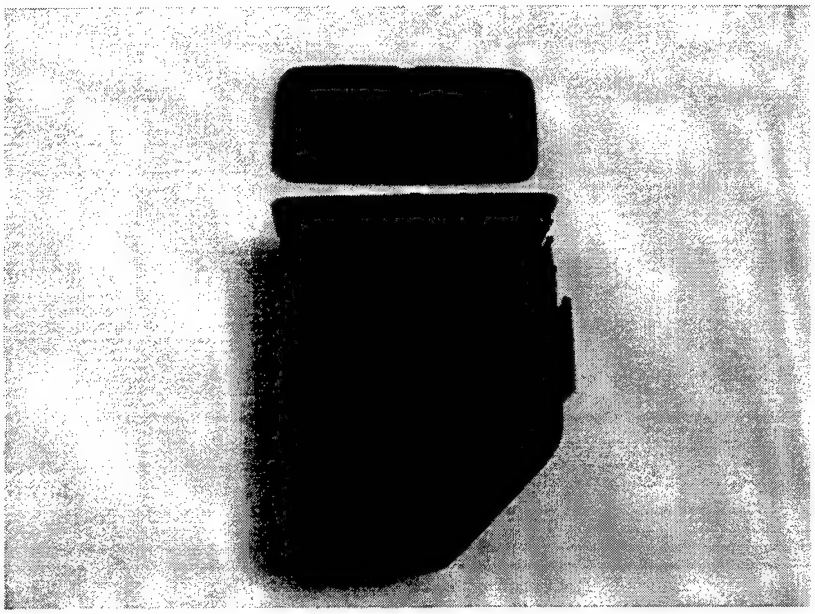


Figure 6: A M249 squad automatic weapon (SAW) empty canister with the lid removed. A hole is punched/drilled in the center of the canister; here a dowel is placed to support up to one hundred feet of white cotton tape.

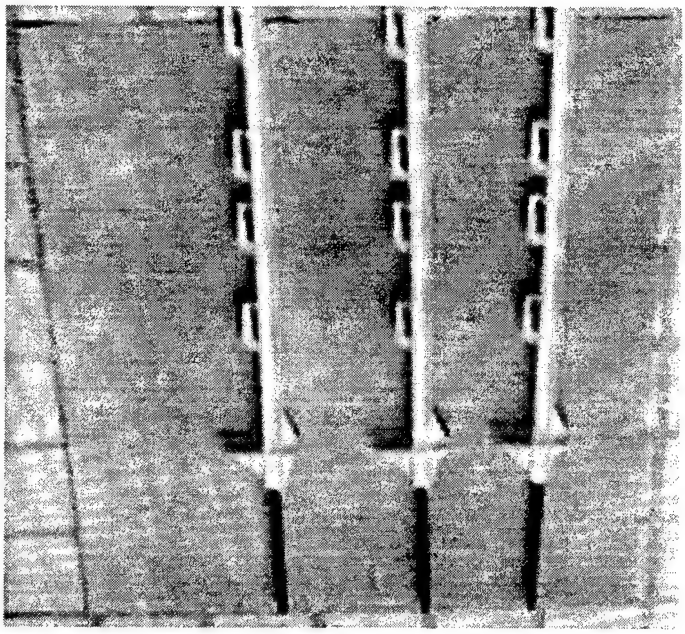


Figure 7: A plastic fencing stake with eight-inch metal tip is excellent for penetrating through hard soils and ice.

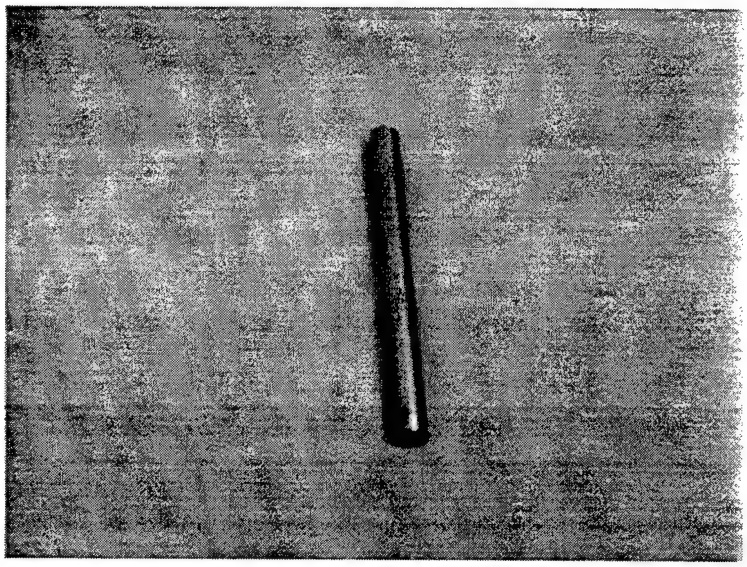


Figure 8: A 3 ¼-inch metal dowel which supports the one hundred feet of white cotton tape inside the SAW canister. This dowel can also be made of plastic or wood.

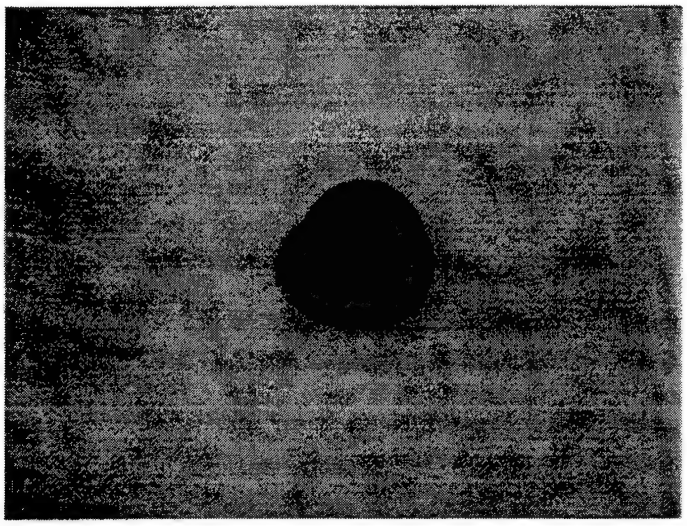


Figure 9: A medal retainer cap. A cotter pin can also be used in constructing SLAMS if plastic or wooden retainer caps are not available.

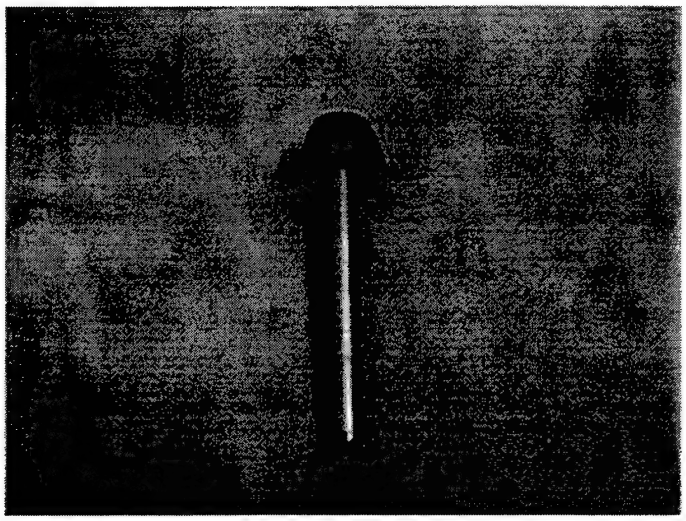


Figure 10: A medal retainer cap attached to a 3¼-inch medal dowel. This will be placed through the center of the empty squad automatic weapons' canister.

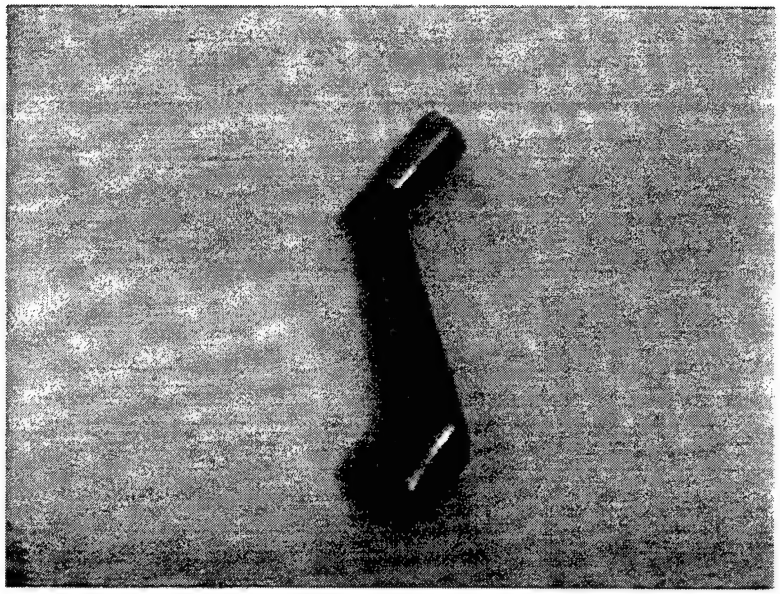


Figure 11: A crank that will be attached to the 3¼-inch medal dowel once it is passed through the empty SAW canister.

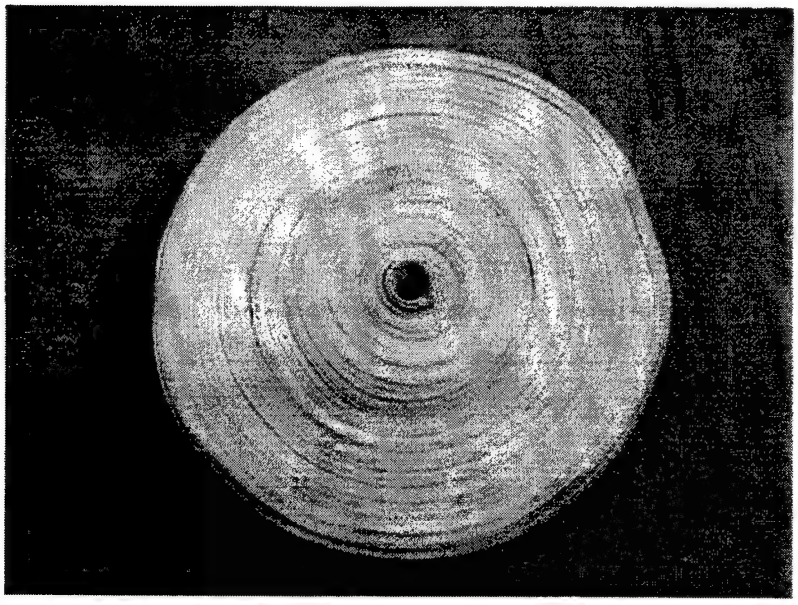


Figure 12: One hundred feet of white cotton tape. The roll of white cotton tape is placed inside the empty SAW canister. Then the 3¼-inch medal, plastic or wooden dowel is passed through the center of the SAW canister and then through the white cotton tape.

SLAMS Capabilities

SLAMS is an easily constructed and man-portable system. SLAMS provides the light combat engineer and light infantry soldier on the battlefield with a unique capability of marking obstacles that are 100 feet in depth, length or circumference with one singular system. A single soldier with limited or no assistance can employ SLAMS within thirty seconds or less to mark an obstacle. The light combat engineer and light infantryman will have fewer problems carrying SLAMS onto the battlefield due to its lightweight. SLAMS is a combat multiplier because it provides for a seamless integration of a system into light units that follows the same employment concept that current conventional obstacle marking systems use. SLAMS provides light units with a marking system that can be employed quickly to provide early warning of off-limit areas to displaced civilians on the battlefield. SLAMS, when employed properly, decreases light combat engineers' and light infantry soldiers' time to mark enemy obstacles. SLAMS will also reduce exposure to troops in a breaching operation, which will help the survivability of light combat engineers and infantry soldiers. SLAMS can be employed faster than wire and picket, traffic cones, highway markers, HEMMS and tippy toms. There is a minimal requirement with SLAMS.

SLAMS Limitations

SLAMS biggest limitation is its durability and sustainability over a long period of time. The materials, in which SLAMS is constructed from can easily be removed or cut away by enemy forces. SLAMS' reduced visibility capability (nighttime) only lasts for approximately forty-eight hours once the infrared liquid chemical light is placed on the

white cotton tape. The SLAMS limited visibility capability (nighttime) will degrade itself as the liquid chemical light dries. As you can see, there are inherent limitations associated with the use of SLAMS. The limitations identified do not outweigh the capabilities SLAMS provides to light combat engineers and light infantry soldiers when marking obstacles on restrictive and severely restrictive terrain. SLAMS' durability over extended periods of time is an issue that can be easily solved by allowing follow-on units moving through the area of operation to upgrade the SLAMS marking system with a more durable wire and pickets marking system.

Operational Employment of SLAMS

In deep operations there are numerous systems within the military's arsenal that require a lot of logistical support. For instance, light scouts who operate at the forward edge of the battle area (FEBA), require a capability that allows them to move quietly and quickly. The lighter the soldier's load, the more efficiently they can move to accomplish their assigned mission. SLAMS allows soldiers to operate with more stealth than the current systems available.

In close combat operations, SLAMS is ideal when fighting against a light force who uses unconventional (guerrilla) tactics by placing mines and other obstacles at key choke points and water crossing sites. Since SLAMS is easily produced, all soldiers and vehicles can easily be equipped with this device. SLAMS is a system that can be easily integrated because it can be emplaced by soldiers of any branch of service or even by civilians. SLAMS will most likely serve as an initial marking system during close operations until a more survivable system can be emplaced by follow-on teams.

In rear operations, SLAMS can be used to mark traffic routes through reduced or cleared minefields. SLAMS can also be used for enhancing the mobility of units by marking routes through battle damaged areas on the battlefield. SLAMS can be used to control unit flow through refueling stations. It can also be used to mark enemy point and scatterable minefields. SLAMS' diversity makes it a critical system to be fielded to light engineer and light infantry units.

Daylight Employment

SLAMS daylight employment requires that the system be employed once employed units can identify the obstacle marking system from approximately fifty to one hundred meters away. Distances could be lengthened or shortened based on the terrain.

Reduced Visibility Employment

SLAMS can be used at night when infrared liquid chemical light is poured onto the white cotton tape and night vision devices (NVGs) are used. This capability is limited to approximately forty-eight hours. Under most conditions, this is approximately how long it will take for the liquid chemical light to dry. Some of the nighttime employment considerations that should be considered for SLAMS are as follows: (1) during night quartering party operations, SLAMS can be used to mark obstacles found in an assembly area; and (2) SLAMS can be used to mark river or stream crossing sites for troop movement.

Specific Employment of SLAMS

SLAMS can be used to mark lanes you do or do not want soldiers to use during military operations on urbanized terrain (MOUT). It can also be used to mark buildings that are off limits.

Defensive Perimeters --SLAMS allows light units to quickly mark lanes through enemy defensive belts. The ability to mark lanes enhances a soldier's survival rate, which allows rapid building of combat power on enemy objectives.

Once the enemy defensive belts are breached, SLAMS can be used to section off areas around enemy battle positions that have been cleared by friendly units. Cleared lanes on battle positions allow friendly forces to maintain contact with the enemy and helps sustain the force while maintaining momentum on the battlefield.

Traffic cones, highway markers, HEMMS, and tippy toms do not provide the same kind of visible boundary as SLAMS when emplaced. The day and night capability of SLAMS supports a leader's directional attacks, while protecting troops from walking or marching into an obstacle that may cause injury and damage to soldiers and equipment.

Shallow Water Crossing--SLAMS provides a unique capability not offered by traffic cones, highway markers, HEMMS, and tippy toms. Since SLAMS has the capability to mark obstacles one hundred feet in length, marking a shallow water crossing is a unique capability only SLAMS can provide. SLAMS can provide light units with a day or night marked crossing site guide that will prevent injury to light combat engineers and light infantry soldiers on the battlefield. This capability allows light units to mark low water areas where assault stream crossings can be conducted safely.

Friendly Obstacles--What is important to note is the capability of SLAMS to be tailored to support maneuver units that will encounter numerous existing and man-made obstacles. Light infantry and light combat engineers can use SLAMS to mark protective and point obstacles within their perimeter. By no means should this become a common practice unless light units are operating on restrictive and severely restrictive terrain where wire and pickets can not be used. As previously stated, SLAMS does not offer the durability associated with wire and pickets, but it can serve as a substitute in it absence.

Acceptance of SLAMS/Validation

The acceptance and the validation of SLAMS is critical to gaining approval for fielding. It is essential that leaders and soldiers are aware of SLAMS' unique capabilities and limitations. By knowing SLAMS' strengths and weaknesses light units will be able to use SLAMS effectively. If unit leaders do not except SLAMS as a viable marking system, light units will continue to have major challenges in marking obstacles on restrictive and severely restrictive terrain. Acceptance of SLAMS by leaders, on the other hand, will lead to continued testing, training, and development of the system.

SLAMS' ease of employment makes it an ideal system to employ during offensive and defensive operations. History shows that obstacle marking allows maneuver elements to maintain their mobility. The purpose of providing SLAMS to light units is to increase their effectiveness and enhance soldier survivability. Light unit commanders should allow some reasonable use of SLAMS, but the key word is "reasonable".

Soldiers should understand that leaders have the right to determine what is a "reasonable" amount. This will be the determining factor that validates SLAMS as being viable system or not.

CHAPTER 4

ANALYSIS

Topic Selection

The objective of this research was to determine if the implementation of SLAMS as a lightweight obstacle marking system could have a positive impact on the ability of light combat engineer and light infantry units to mark obstacles. In this research, the organizations selected had never conducted an assessment which indicated that light obstacle marking systems needed to be provided to enhance their abilities to mark obstacles on restrictive and severely restrictive terrain while reducing soldiers exposure to direct and indirect weapons systems. Therefore, more research is needed to assess factors contributing to why light units are given last priority in updating obstacle-marking techniques. It would be beneficial for light organizations to identify weaknesses with current obstacle marking methods and provide alternatives to improve current systems or validate new systems.

Performing the Research

The sample population in this research included eighty engineer and infantry leaders. There were four methodologies used to evaluate the data--qualitative and quantitative was the focal point of each method. The results of the data collected were annotated in both qualitative and quantitative form (see figure 13). Tables were designed and used to display the quantitative data. Qualitative data was presented through recurring themes identified in written comments from respondents. This included the use of one questionnaire form. Leaders within light, mechanized, CTC and TRADOC

organizations received an Information paper on SLAMS, a picture of a constructed emplaced SLAMS and a survey,

An information paper was given to leaders in the field to provide them with detailed information about SLAMS and its capability to enhance light combat engineers and light infantry unit's assault obstacle marking on restrictive and severely restrictive terrain. To the majority of the leaders in the field, SLAMS in a new concept. This information paper was instrumental in providing leaders with a better understanding of how SLAMS could be employed on the battlefield in the future.

A picture of a constructed emplaced SLAMS (see appendix B) was also sent to the leaders in the field to provide them with visual product. The picture was also instrumental in providing leaders with a better understanding of how simple it is to construct SLAMS. Most leaders commented that the picture enhanced their opinion of the SLAMS and its capability to enhance light combat engineers and light infantry soldiers mark obstacle on restrictive and severely restrictive terrain.

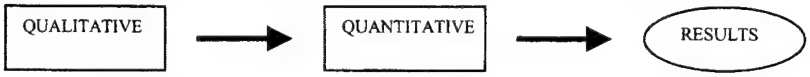
The survey (see appendix A) was distributed to all leaders by email. The survey included twenty-two questions. Questions 1, 2, 3, 5 and 6 were not measured by a five point Likert-type scale. Questions 4 and then 7 through 23 were measured on a five-point Likert-type scale. The scale was anchored (1) Agree, (2) Slightly Agree, (3) Neither Agree nor Disagree, (4) Slightly Disagree, and (5) Disagree. After question (23), there was a space left open to allow participants to explain their responses or provide additional comments. A total of 250 surveys were emailed to participants. The survey did not include demographic questions such as race and sex as these were determined to be irrelevant.

Each leader received a questionnaire with a cover letter requesting his or her participation. The cover letter had two purposes: (1) to describe the purpose for the research; and (2) to ensure respondents that the information obtained would be strictly confidential and reported in an aggregate form so the identity of an individual respondent could not be determined.

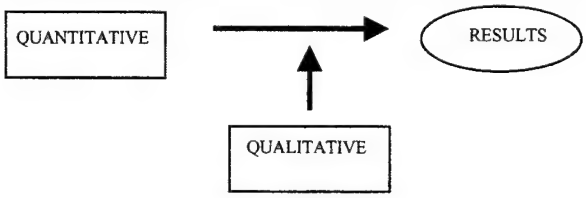
The cover letter also specified when the surveys needed to be returned and the location for the surveys to be returned. A survey collection box was not used because use of email would be convenient for respondents to return the surveys. Eighty respondents completed and returned the survey, resulting in a 32 percent return rate. This process occurred from 16 February to 13 March 2000.

The analysis for this research project is based on the information received from different organizations that answered and returned the survey. A brief summarization of each question asked in the survey will be given. The research paper will discuss how critical each response is to the success of implementing SLAMS as a viable option for marking obstacles on restrictive and severely restrictive terrain. Additionally, the research paper will discuss active measures that leaders should take to prepare their organizations for success on today's battlefield while operating in a changing environment. Since there were two focused groups for the research topic, each question has been divided into two parts; the answers engineer leaders provided and second, the answers provided by infantry leaders. The analysis of the returned responses will be based solely on information received telephonically or by survey. The research paper analysis will directly reflect the concerns of the leaders in the field and schoolhouse environments.

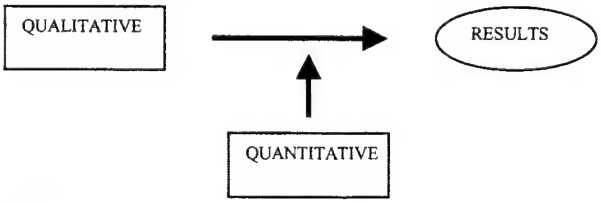
Model 1: Qualitative methods are used to help develop quantitative measures and instruments.



Model 2: Qualitative methods are used to help explain quantitative findings.



Model 3: Quantitative methods are used to embellish a primary qualitative study.



Model 4: Qualitative and quantitative methods are used equally and parallel.

Figure 13: Four possible ways that qualitative and quantitative methods may be measured.

Table 1 shows the number of surveys returned by the deadline. Table 1 also shows the breakdown by branch of service.

Table 1. Results of Question 1: What is your branch?"	
Engineer	Infantry
62	28
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000	

Table 2 indicates that the majority of the population that returned their surveys had experience in light units of some type. This is important for acceptance since light combat engineers and the light infantry should have a better understanding of the SLAMS concept and its impact on obstacle marking.

Table 2. Results of Question 2: Have you served in one or more of these type corps/divisional units?				
	Airborne	Air Assault	Light	None
Engineer	60%	34%	27%	23%
Infantry	61%	71%	50%	21%
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000				

Table 3 indicates that the majority of the surveyed population had gained most of their experience within their units, whereas a smaller population would most likely

have a boarder perspective due to their CTC experience and having the opportunity to watch numerous units going through rotations at one or more of the CTCs.

Table 3. Results of Question 3: Have you ever served as a CTC O/C?		
	Yes	No
Engineer	6%	94%
Infantry	11%	89%
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000		

Table 4 indicates that there is a major concern by leaders in the field that light units need a viable obstacle marking system that they can employ on restrictive and severely restrictive terrain.

Table 4 Results of Question 4: Do you believe that light units have a difficult time marking obstacles on restrictive or severely restrictive terrain due to them not having a man-portable system?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	77%	13%	10%		
Infantry	79%	21%			
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 5 indicates that even though some light weight system is needed most units are still using some form or version of the systems used by mechanized units. Thus, SLAMS may be a viable option if introduced to light combat engineers and light infantry units in the field and schoolhouse for testing.

Table 5. Results of Question 5: Are you familiar with the SLAMS concept?		
	Yes	No
Engineer	10%	90%
Infantry		100%
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000		

Table 6 indicates that most units may not be looking for innovative ways to reduce soldiers exposure to direct and indirect fire weapon systems. They may be making the assumption that in all environments they will have the conditions set to conduct obstacle breaches with their current systems.

Table 6. Results of Question 6: Does your organization have a system similar to SLAMS?		
	Yes	No
Engineer	10%	90%
Infantry		100%
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000		

Table 7 indicates that leaders in the field have identified that lighter systems for marking obstacles are needed, although no one is aggressively pushing the design of something new, as seen in earlier data.

Table 7. Results of Question 7: Do you agree that light units need a reliable light weight obstacle marking system?

	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	84%	13%	3%		
Infantry	86%	11%	4%		

Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000

Table 8 indicates that the majority of the unit leaders agree or slightly agree that SLAMS is an acceptable solution for light combat engineers and infantry soldiers to mark obstacles on restrictive and severely restrictive terrain.

SLAMS' light weight and ease of employment has received praise by the soldiers of Charlie Company, 326th Engineer Battalion (Air Assault), as previously stated in the research paper. SLAMS appeals to the leader because it provides them with an alternative obstacle marking system to the traffic cone, highway marker, HEMMS poles and tippy toms.

Based on surveyed information no conclusions can be made to the reason why some engineer and infantry leaders do not believe that SLAMS is an acceptable solution for marking obstacles within their areas of responsibility (AOR). It could have been from

a variety of reasons ranging from unit leaders never having the opportunity to train with SLAMS or a system similar to it in a tactical or simulated tactical environment. Finally, all of the negative responses could be coming from heavy mechanized engineers and infantry leaders.

Leaders in the field have stated within their surveys, that they will train with SLAMS if it is made available to them. Hopefully, this research study of the SLAMS system in comparison to traffic cones, highway marker, HEMMS poles, and tippy toms will help provide leaders in the field with information needed to evaluate SLAMS as a viable marking system. SLAMS acceptance must be based on leader testing, observations and evaluations. Without this training and evaluation phase SLAMS will never be fully integrated to support maneuver units on the battlefield.

Table 8. Results of Question 8: Do you think SLAMS is an acceptable solution for a light unit?

	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	32%	48%	19%		
Infantry	29%	69%	4%		

Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000

Table 9 indicates that infantry leaders seemed to appreciate of the ease of construction of SLAMS. Engineer leaders were basically divided between agree and slightly agree. The ease of procurement of items for the construction of SLAMS allows

units at every level the maximum opportunity to train with SLAMS due to it compositional makeup.

Table 9. Results of Question 9: Do you believe parts used to build SLAMS can easily be procured locally at your home-station?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	48%	53%			
Infantry	100%				
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 10 indicates that all leaders are in agreement that SLAMS is easy to construct, since it allow leaders and soldiers a wide range of flexible alternatives. Since SLAMS can be constructed within three to five minutes, leaders may choose to assemble SLAMS at their objective rally point (ORP), prior to deployment at home station, or at their Initial Staging Base (ISB).

Table 10. Results of Question 10: Do you agree that SLAMS can easily be constructed?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	94%	6%			
Infantry	93%	7%			
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 11 indicates that leaders in the field had some reservations of the durability of SLAMS on the battlefield. SLAMS is a system that leaders should consider using during assault obstacle marking, shallow water crossing, or for friendly obstacles when time does not permit soldiers from marking the obstacle to standard with wire and pickets.

SLAMS is not a stand-alone system that leaders can use to replace wire and picket marking standards. SLAMS should not be considered a viable solution for marking obstacles on the battlefield that are not going to be cleared or upgraded with wire and pickets within five to seven days.

As previously stated in the research paper, SLAMS has day and night capability. But SLAMS' reduced visibility capability is only good for approximately forty-eight hours as stated earlier.

SLAMS' purpose is to allow the unit in contact to maintain its momentum in battle while providing safe passages through enemy obstacles. Follow-on units should always be identified and tasked to upgrade SLAMS marked obstacles whenever they are passing through the area or initial breach where the obstacle has been reported.

Table 11. Results of Question 11: Do you agree that SLAMS is durable enough for light combat operations?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	24%	52%	11%	13%	
Infantry	18%	43%	25%	14%	
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 12 indicates that the majority of the leaders surveyed felt that SLAMS was an excellent assault marking system. Its light weight, speed in which it can be employed, and the unique ability allowed by having only one soldier exposed to enemy fire during emplacement makes it an excellent system for assault marking.

Table 12. Results of Question 12: Do you agree SLAMS can be used for assault breaching?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	97%	3%			
Infantry	100%				
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 13 indicates that leaders believe SLAMS can provide them with a viable option for assault marking of obstacles on restrictive terrain. Some of the comments received back with the surveys were referenced toward hard surface terrain, like rocks or

ice. SLAMS may be used in some cold weather climates, but in most cases SLAMS would most likely not be used to mark rocky surfaces unless there are soft surfaces that SLAMS can penetrate at the entrance and exit of the obstacle. Use of SLAMS in these geological environments would be a leader's decision based on the situation. SLAMS testing and training is very important because it allows the leaders and soldiers in the field to understand SLAMS advantages and limitations.

Table 13. Results of Question 13: Do you agree SLAMS can improve lane/obstacle marking on restrictive and severely restrictive parts of the battlefield?

	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	90%	10%			
Infantry	68%	32%			

Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000

Table 14 indicates that leaders in the field clearly believe that SLAMS is a more suitable system for assault breaching in comparison to traffic cones. Disadvantages of traffic cones are irregular shape, weight of traffic cones, no night employment capability with traffic cones and the number of soldiers required to emplace the system. It also requires soldiers to be exposed to direct and indirect fires for a long period of time during employment.

The advantages of SLAMS over traffic cones is there are no irregular shapes that hamper a soldier's load; it is a light weight system with an increased marking capability;

it has a reduced visibility employment capability; it requires only one soldier to employ marking system during assault breaches; and it clearly reduces the time a soldier is exposed to direct and indirect fires.

Table 14. Results of Question 14: Do you agree SLAMS is a more feasible system than traffic cones for marking lanes/obstacles on restrictive and severely restrictive parts of the battlefield?

	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	100%				
Infantry	100%				

Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000

Table 15 indicates that leaders in the field clearly believe that SLAMS is a more suitable system for assault breaching in comparison to highway markers. Disadvantages of highway markers are irregular shape, weight, no night employment capability, and the number of soldiers required to emplace the system. It also requires soldiers to be exposed to direct and indirect fires for a long period of time during employment.

The advantages of SLAMS over highway markers are: no irregular shapes that hamper a soldier's load; light weight system with an increased marking capability; it has a night employment capability; it requires only one soldier to employ during assault breaches; and it clearly reduces the time soldier is exposed to direct and indirect fires systems.

Table 15. Results of Question 15: Do you agree SLAMS is a more feasible system than highway markers for marking lanes/obstacles on restrictive and severely restrictive parts of the battlefield?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	100%				
Infantry	100%				
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 16 indicates that leaders in the field clearly believe that SLAMS is a more suitable system for assault breaching in comparison to HEMMS. But some leaders believe that HEMMS is still an option for assault obstacle marking. The disadvantages of HEMMS are fewer than traffic cones, highway markers and tippy toms. Its biggest disadvantage is the number of soldiers required to emplace the system and it requires soldiers to be exposed to direct and indirect fires for a longer period of time during employment than SLAMS. The advantages that SLAMS has HEMMS are similar to the advantages discussed for traffic cones and highway markers.

Table 16. Results of Question 16: Do you agree SLAMS is a more feasible system than the hand-emplaced minefield marking set for marking lanes/obstacles on restrictive and severely restrictive parts of the battlefield?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	79%	15%	6%		
Infantry	75%	25%			
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 17 indicates that leaders in the field clearly believe that SLAMS is a more suitable system for assault breaching in comparison to tippy toms. Disadvantages of tippy toms are irregular shape; weight; no night employment capability; and the number of soldiers required to emplace the system. It also requires soldiers to be exposed to direct and indirect fires for a long period of time during employment.

The advantages of SLAMS over tippy toms are: no irregular shapes that hamper a soldier's load; light weight system with an increased marking capability; has a night employment capability; SLAMS requires only one soldier to employ during assault breaches; and SLAMS clearly reduces the time that a soldier is exposed to direct and indirect fires .

Table 17. Results of Question 17: Do you agree SLAMS is a more feasible system than tippy toms for marking lanes/obstacles on restrictive and severely restrictive parts of the battlefield?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	100%				
Infantry	100%				
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 18 indicates that leaders in the field tended to support the idea that SLAMS is a viable offensive system. Most of the leader responses to the questions further validated that SLAMS can definitely be used in offensive operations.

Table 18. Results of Question 18: Do you agree SLAMS can be used in offensive operations?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	92%	8%			
Infantry	100%				
Sapper Lane Assault Marking System(SLAMS) Response to Survey, 2000					

Table 19 indicates that leaders are not quite sure that SLAMS can be used in defensive operations because of their limited knowledge and observation of SLAMS. SLAMS durability after being emplaced over a long period of time is questionable at

best. Further testing in this area should be conducted to support or deny leaders' reservations.

Table 19. Results of Question 19: Do you agree SLAMS can be used in defensive operations?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	32%	61%	6%		
Infantry	75%	25%			
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 20 indicates that leaders are not quite sure that SLAMS can be used in OOTW operations because of their limited knowledge and observation of SLAMS. Through training with SLAMS, tactic, technique and procedures (TTP) can be developed. Further testing in this area should be conducted to support or deny leaders reservations.

Table 20. Results of Question 20: Do you agree SLAMS can be used in OOTW missions?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	32%	42%	14%		
Infantry	21%	71%	7%		
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 21 indicates that leaders in the field believe that SLAMS can be used on today's battlefield. Training will be required by units in order to validate unit employment battle drills.

The hesitation of leaders to fully accept the SLAMS concept is simple to identify. Leaders lack understanding of the SLAMS system because it is a new system and they have never trained with it before. With this said, leaders will have to come up with ways during their training how SLAM can and will be employed.

The hesitation of leaders to fully accept the SLAMS' concept could be solely based on the durability issues associated with SLAMS. Since SLAMS is not as durable as wire and pickets, it should not be considered a stand-alone system. This could be a major issue for leaders in the field.

Finally, it may be an issue with unfamiliarity (recognition issue) with leaders in the field since SLAMS is a new concept. Further research would have to be conducted to find out what is causing the leaders in the field to be cautious in their acceptance of SLAMS as a lightweight marking system.

Hopefully, with additional training and observation by leaders in the schoolhouse and in the field, SLAMS will continue to gain support in the future. Should this happen, SLAMS may find its way onto today's battlefield as a combat multiplier for the light combat engineer and the light infantryman.

Table 21. Results of Question 21: Do you agree SLAMS can be employed on the modern day battlefield?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	87%	13%			
Infantry	75%	25%			
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

Table 22 indicates that leaders in the field are willing to accept SLAMS and train with it. Acceptance is essential to the survival of SLAMS. Without it, units will not train with SLAMS to validate it use. From the responses given within the survey, SLAMS will most likely in the near future find its way onto the battlefield. Changes may be made to the design of the SLAMS prior to fielding, but the concept will remain the same.

Table 22. Results of Question 22: Will you train with SLAMS?					
	Agree	Slightly Agree	Neither Agree or Disagree	Slightly Disagree	Disagree
Engineer	100%				
Infantry	100%				
Sapper Lane Assault Marking System (SLAMS) Response to Survey, 2000					

CHAPTER 5

SUMMARY

Introduction

It is appropriate to begin this chapter with a reminder of the purpose of the research. The original thesis question under study asked whether the Sapper Lane Assault Marking System (SLAMS) would enhance light infantry and light combat engineer's ability to standardize minefield marking.

In addition to standardizing minefield marking, it should be clear that SLAMS also provides light infantry and light combat engineers with an increased capability in mobility and force protection that light combat engineers and light infantry forces so desperately need.

SLAMS also provides light combat engineers and light infantry forces with a better marking system to accomplish its mission on restrictive and severely restrictive terrain.

With that said, in order to gain these capabilities, SLAMS was designed with limitations outlined within the research paper. The primary limitation is the loss of some durability over a long period of time when it is compared to wire and pickets.

Some leaders believe SLAMS is a great system and other leaders are convinced that the developing, testing and fielding of the SLAMS may be a waste of time. As the research study started to take shape, it became evident that both groups were partially correct.

Related Issues

During the research process, four questions concerning SLAMS became evident. The actual questions or concerns identified by leaders in the field were forwarded within the participant's survey. While these questions do not directly answer the primary question, the research paper will address the four major questions most leaders in the field were concerned with. The four questions listed below will make excellent research topics for officers attending the Command and General Staff College in the future. The reason to conduct this additional research in the future is to confirm or deny leader concerns. The four outlying questions are:

1. Should SLAMS be developed as a durable stand-alone system?
2. Should SLAMS be used as a land based system only?
3. What number of SLAMS assets does a division need?
4. Can SLAMS be tailored to operate in a digitized environment?

Questions 1 and 2 can be answered with a simple no. Questions 3 and 4 will depend on the mission assigned to the unit and how much funding SLAMS will receive if it is accepted by the leaders in the field. The remainder of this chapter will first explain the reasoning behind the answer to the three questions and then present and compare possible solutions to the primary research question.

Should SLAMS be Developed as a Durable Stand-Alone System?

Throughout the short history of SLAMS, this question has been asked and answered repeatedly. The original requirement was for some sort of lightweight obstacle marking system that was man packable. At that time, it was clear that SLAMS could

provide this capability. During the early considerations for construction, SLAMS main purpose was to enhance speed of obstacle marking while reducing the soldier's load. When SLAMS was envisioned in this role, the need for a stand-alone system was never considered. SLAMS would be employed to provide faster lane markings for breaches while limiting the exposure of light combat engineers and light infantry breach forces.

Since the development of SLAMS, it has always been considered a system that was designed for initial marking of obstacles. SLAMS is not a stand-alone system. It is a mobile, lightweight obstacle marking system that should be used to assault through complex obstacle systems where enemy forces provide overwatching security by direct or indirect fires.

The reason why SLAMS does not have to be a stand-alone system is because follow-on engineer units can upgrade the SLAMS system with a currently available military marking system such as wire and pickets. Due to the fog and friction associated with combat, units seldom have time to mark obstacles properly during engagements with enemy units. And finally, seldom will units carry enough barrier material with them on offensive operations to mark obstacles to standards.

In most cases, in order to maintain contact with the enemy, units only have enough time to do an initial marking of a passage lane through an obstacle. They rely on follow-on units to upgrade the lane once locations have been reported to higher.

The SLAMS system provides the user/operator with protection by allowing for quick marking of obstacles under fire. The most dangerous mission for light engineers using SLAMS is breaching. When used in this role, the light engineer and SLAMS should be integrated as part of a combined arms team. The supported maneuver unit

must provide security for the SLAMS user. Typically, units will provide a support by fire element to provide security for the SLAMS user. The light infantry can provide heavy suppressive fires with their organic weapons systems while in an overwatch position. Based on this, it would be of little additional value to have SLAMS as a stand-alone system.

When SLAMS is used in a defensive role, it can be used to mark protective and conventional minefields close to individual fighting positions or out in the battle area. It can also be used to mark lanes through obstacles where units will pass through prior to closing in preparation for the main attack. SLAMS is a great obstacle marking system when used within its designed capabilities.

Additionally, if SLAMS becomes a stand-alone system, more work will be required of the soldier to employ it. More materials will be needed in order to make it more durable as a stand-alone system, SLAMS would most likely require an additional soldier to assist in its employment

Making SLAMS a stand-alone system requires units to design more complexed battle drills. This requires units to allocate more training time to ensure soldiers are proficient at obstacle marking with the system. These seemingly small enhancements will most likely impair the soldier's ability to employ SLAMS as quickly as it can be employed now.

Since the construction of SLAMS and its use in training in the 101st Airborne Division (Air Assault), the Joint Readiness Training Center (JRTC) and the Sapper Leaders course, there has never been a report by an observer-controller that SLAMS

would work best as a stand-alone system. Finally, there is no document that mandates what should be used in initial assault marking systems.

Should SLAMS be Used as a Land Based System Only?

Enemy forces consistently mark-crossing sites where troops may pass. Since the first SLAMS was designed, the system has been capable of marking obstacles lanes in shallow streams and river crossing sites. There are several reasons why SLAMS should be used to mark shallow water crossing sites and marsh areas.

For years, United States Army doctrine prepared to fight a conventional war against the Soviet Union. This war would have most likely been fought in Europe. European terrain has numerous rivers, streams, and ford sites. Should light soldiers have to fight today on that very same terrain, the rivers, streams, and ford sites still exist.

Today, our doctrine is evolving and we are training to fight in an unconventional environment. Enemy forces consistently emplace mines and other obstacles at water crossing sites. SLAMS can be used to mark cleared lanes by staking off the near and far shore. This gives the soldier on the ground a safe and visible lane to pass through.

Soldiers never know when or where our nation will call upon them to serve. The need to operate on restrictive and severely restrictive terrain will continue to increase. SLAMS will support action in many different scenarios and water obstacle marking is just one more task added to the list.

Even if all the Army's equipment was amphibious-capable and all soldiers knew how to swim, having a capability that marks entry and exit points at a water crossing site is definitely better than nothing at all. Marking lanes regardless of water or dry land

reduces risk to soldiers. This capability comes with the system at no added cost to the unit or added weight for the soldier to carry. Safety considerations for light combat engineers and light infantry soldiers should also be taken into consideration.

Our current river crossing doctrine outlined in FM 90-13, *River Crossing Operations*, also talks about the importance of marking the entry and exit of water obstacles. Regardless of the depth, its good practice to mark water-crossing sites to ensure, under limited visibility, soldiers can locate the site crossing.

What Number of SLAMS Assets Does a Division Require?

Question 3 is a difficult question to answer. Our light units are always deploying as part of a crisis reactionary force. With that said, it would be almost impossible to make an assumption on how many SLAMS systems are required to support a division.

As stated earlier, SLAM is a simple system to construct. It would be easier for a unit to base their construction of SLAMS on the mission they will have to perform. This will require leaders to conduct a thorough engineer battlefield assessment as part of the intelligence preparation of the battlefield (IPB) to identify requirements for the construction of SLAMS.

Units can come up with their on basic load requirements based on their training and mission needs. This will vary from unit to unit, because of contingency missions that and training operational tempo.

A good case can be made for not requiring a set number of SLAMS in a unit based on the cost to construct. SLAMS can be constructed in two to three minutes and the cost for all the materials is minimal in comparison to all the other systems discussed

within the research paper. It would not be difficult to construct the needed SLAMS system under time constraints.

The two major areas mentioned above that will assist unit leaders in justifying how many SLAMS are needed within a division should be based on deployment and training requirements. Someone in the battalion or company operations office can track training and mission use. The empirical data gained will possibly allow units to calculate the number of SLAMS needed for specific missions after a period of time.

Can SLAM be Tailored to Operate in a Digitized Environment?

SLAMS should be designed with a digitized capability that allows units to track marked obstacles on the battlefield. Adding a sensor tracking (transmitter) capability within the design of SLAMS will raise the price of procurement and fielding. However, it is definitely a capability that SLAMS should be constructed with to reduce injuries to soldiers and displaced civilians on today's battlefield.

The only foreseeable problem with adding a sensor tracking capability would be the funding. As the armed services continue to reduce in size, funding of new technology based systems will be limited. Should sensor tracking be a requirement for leaders to accept SLAMS as a viable obstacle marking system for light combat engineers and light infantry on restrictive and severely restrictive terrain? Leaders in the field or at the United States Army Engineer school should develop a mission need statement outlining the necessity of sensor tracking within the design of SLAMS.

By constructing SLAMS with a sensor tracking capability, units should be able to move about the battlefield with increased mobility. Follow-on units should be able to

locate and bypass obstacles during day and night operations easier than ever before on the battlefield with limited loss to personal and unit mobility.

The Difficult Question

The four easiest questions have been answered. The difficult question remains: Will SLAMS enhance light infantry and light combat engineers' capability to mark obstacles on restrictive and severely restrictive terrain? Six options will be examined and discussed in accordance with leader responses from the field, United States Army Engineer School, CTC observer-controllers, and research on the capabilities and limitations of traffic cones, highway markers, HEMMS and tippy toms.

Advantages and disadvantages for each option will be discussed. A number of options have been deliberately omitted. For example, options that would introduce new equipment not discussed within the research paper were omitted. A satisfactory solution can be reached without further complicating the question researched. The six options to consider are:

Option 1. This option is the no change option. The light divisional units keep their current obstacle marking systems and do not field SLAMS.

Option 2. This option requires light units to use SLAMS and HEMMS together since both have a day/night capability.

Option 3. This option requires light units to use SLAMS and highway markers together. For example, SLAMS can be used for night employment because it has a limited visibility capability and the highway markers are used during the day because it does not have a limited visibility capability.

Option 4. This option requires initial marking of obstacles with SLAMS, then follow-on units upgrade with wire and pickets after the obstacle location has been reported to higher.

Option 5. This option requires light units to use SLAMS and traffic cones together. For example, SLAMS can be used for night employment because it has a limited visibility capability and the traffic cones are used duing the day because it does not have a limited visibility capability.

Option 6. This option requires light units to use SLAMS and tippy toms together. For example, SLAMS can be used for night employment because it has a limited visibility capability and the tippy toms are used during the day because it does not have a limited visibility capability.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter focuses directly on the thesis question which this research paper addressed. Will SLAMS enhance light infantry and light combat engineer's capability to standardize minefield marking on restrictive and severely restrictive terrain?

The conclusions and recommendations accurately reflect information received back from leaders and soldiers in the field. Future research studies should be conducted to find viable solutions to enhance the light infantry and light combat engineer's capabilities to operate on restrictive and severely restrictive terrain.

Conclusions

Conclusions drawn from the research analysis and the telephonic interviews clearly confirm that leaders in the field acknowledge that light infantry and light combat engineers need a lightweight system to mark obstacles on restrictive and severely restrictive terrain.

Leaders in the field have also started to evaluate and identify problems associated with light infantry and light combat engineers operating on terrain where higher headquarters, at best, can only provide minimal support.

What light infantry and light combat engineer soldiers carry onto the battlefield during initial entry must sustain them and provide for follow-on movement of a larger element.

Leaders have clearly shown through their survey responses that SLAMS can be a viable option for marking obstacles on restrictive and severely restrictive terrain. The use of SLAMS may be the difference between marking an obstacle or leaving it unmarked. Hopefully, the employment of SLAMS will prevent innocent displaced civilians, light infantry and light combat engineer soldiers, and follow-on units from wandering into minefields or other type obstacles on the battlefield.

The surveys returned did not always totally agree with the full concept of SLAMS. This can be attributed to SLAMS being a new system and leaders must have more time to train, observe and evaluate SLAMS in the field to actually gain an appreciation for the value of SLAMS.

Leaders stated, however, that they would train with SLAMS if it was made available to them. With training, units will be able to design battle drills that will support the use of SLAMS on the battlefield.

Most leaders understand that SLAMS is not a stand-alone system. SLAMS is an initial obstacle marking system that allows maneuver units to maintain contact with the enemy in offensive operations. SLAMS can also be used to mark lanes through friendly obstacles prior to their closure and can be used to mark conventional and protective minefield boundaries of friendly obstacles in the defense when wire and pickets are not available.

Recommendations

The six options discussed in chapter 5 all have advantages and disadvantages. These options could have been be mixed and matched even more, but each would still have the same inherent characteristics.

Option 4 is the best course of action for light infantry and light combat engineers. This option requires initial marking of obstacles with SLAMS, then follow-on units upgrade with wire and pickets once the obstacle location has been reported to higher headquarters.

Option 4 (SLAMS and wire/picket) enhances mobility for the light infantry and light combat engineer soldier on the ground. It provides safe lane passages for follow-on units. This initial marking of obstacles by light infantry and light combat engineers supports identifying the location of the obstacles' entry and exit points which allow follow-on units to mark obstacles a lot faster and a lot safer.

Option 4 (SLAMS and wire/picket upgrade) also enhances breaching force survivability rates by limiting the exposure of the soldier to lethal direct and indirect fires on the battlefield. One soldier can easily employ SLAMS. With that said, SLAMS limits the number of targets the enemy can engage at the breach site. Additionally, SLAMS is less resource intensive to move around the battlefield than all the other marking systems discussed.

Finally, Option 4 (SLAMS and wire/picket upgrade) decreases the demand for logistics during the initial phases of the operation. Since units will be able to carry most of the initial marking systems with them, a thorough intelligence preparation of the

battlefield must be conducted to inform the light infantry and light combat engineer leaders of what is initially required to be marked.

Future Research

It would be beneficial to conduct a study to determine if the lack of a light assault obstacle marking system has impacted the success of light units to execute their mission on restrictive and severely restrictive terrain.

It would also be beneficial to conduct a study to determine how many SLAMS should be issued to a light division if in the future SLAMS is adopted as an Army initial marking system for light units on restrictive and severely restrictive terrain.

APPENDIX A

SAPPER LANE ASSAULT MARKING SYSTEM SURVEY

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Sapper Lane Assault Marking System (SLAMS) Survey

You are a leader within your organization. Think back upon your experiences and try to remember how many obstacle marking systems you have seen utilized in different units? As you well know, obstacle marking is conducted differently from unit to unit. This is an area where we should strive to standardize. By doing so, reduced training will be required for soldiers arriving from one unit to the next. After reading the information paper on SLAMS, you should have a pretty good concept of how it can be employed. Your answers to this survey could/will support change. Your answers will remain confidential and will only be used as part of my research to support or deny the implementation of SLAMS into units in the future.

Please answer the following questions by circling your most appropriate response:

1. What is your branch? Engineer Infantry

2. Have you served in one or more of these type Corps/divisional units? Please circle all that apply.
Airborne Air Assault Light None

3. Have you ever served as a CTC O/C? Yes No

4. Do you believe that light units have a difficult time marking obstacles on restrictive or severely restrictive terrain due to them not having a man-portable system?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

5. Are you familiar with the SLAMS concept? Yes No

6. Does your organization have a system similar to SLAMS? Yes No

7. Do you agree that light units need a reliable lightweight obstacle marking system?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

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Sapper Lane Assault Marking System (SLAMS) Survey

8. Do you think SLAMS is an acceptable solution for light unit?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

9. Do you believe parts used to build SLAMS can easily be procured locally at your home-station?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

10. Do you agree that SLAMS can easily be constructed?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

11. Do you agree that SLAMS is durable enough for light combat operations?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

12. Do you agree SLAMS can be used for assault breaching?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

13. Do you agree SLAMS can improve lane/obstacle marking on restrictive and severely restrictive parts of the battlefield?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

14. Do you agree SLAMS is a more feasible system than traffic cones for marking lanes/obstacles on restrictive and severely restrictive parts of the battlefield?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

15. Do you agree SLAMS is a more feasible system than highway markers for marking lanes/obstacles on restrictive and severely restrictive parts of the battlefield?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

16. Do you agree SLAMS is a more feasible system than the hand-emplaced minefield marking set for marking lanes/obstacles on restrictive and severely restrictive parts of the battlefield?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

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Sapper Lane Assault Marking System (SLAMS) Survey

17. Do you agree SLAMS is a more feasible system than tippy toms for marking lanes/obstacles on restrictive and severely restrictive parts of the battlefield?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

18. Do you agree SLAMS can be used in offensive operations?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

19. Do you agree SLAMS can be used in defensive operations?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

20. Do you agree SLAMS can be used in OOTW missions?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

21. Do you agree SLAMS can be employed on the modern day battlefield?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

22. Will you train with SLAMS?
1. Agree 2. Slightly Agree 3. Neither Agree or Disagree 4. Slightly Disagree 5. Disagree

General Comments:

Name: Organization: Duty Position:

Thank You. Your survey will be kept confidential at all times.

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APPENDIX B

SAPPER LANE ASSAULT MARKING SYSTEM PICTURE

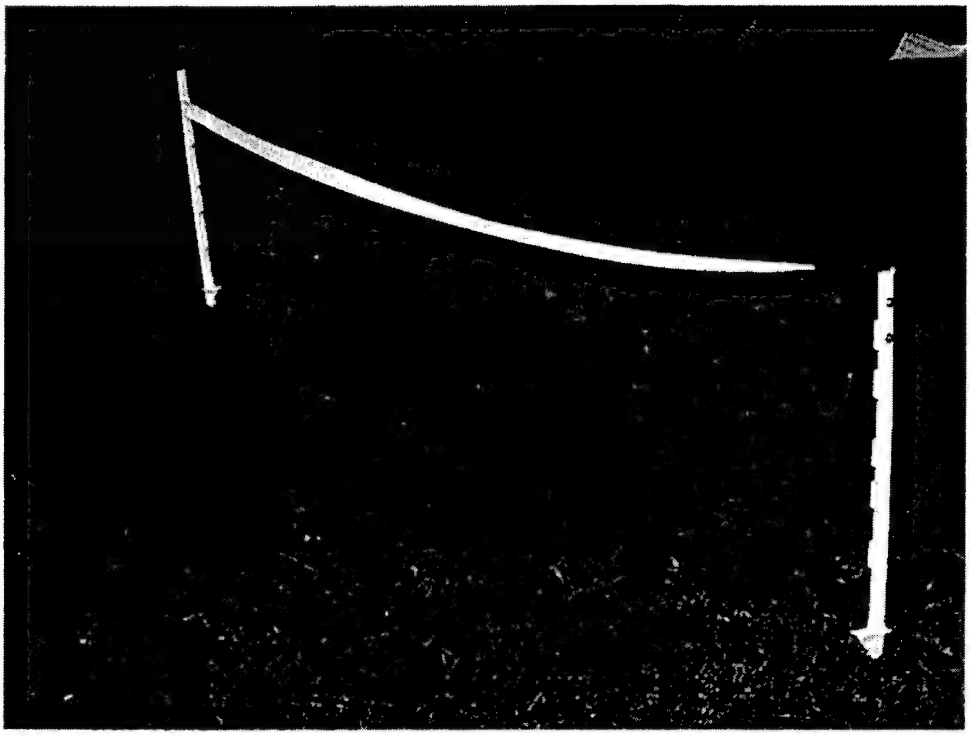

Figure 14: An emplaced SLAMS system.

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